MODEL 3310A

FUNCTION GENERATOR

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

D IN U.S.A.

OPERATING AND SERVICE MANUAL

-hp- Part No. 03310-90001

MODEL 3310A

FUNCTION GENERATOR

Serials Prefixed: 947-
*Appendix C, Manual Backdating Changes, adapts this manual to serials prefixed: 920-

Copyright Hewlett-Packard Company 1969
P.O. Box 301, Loveland, Colorado 80537 U.S.A.

Printed: Jan 1970

HEWLETT hp PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

TABLE OF CONTENTS

Section Page

I GENERAL INFORMATION 1-1
1-1. Introduction 1-1
1-3. Specifications 1-1
1-5. Description 1-1
1-9. Instrument and Manual Identification 1-1

Section Page

II INSTALLATION 2-1
2-1. Introduction 2-1
2-3. Inspection 2-1
2-5. Power Requirements 2-1
2-7. Grounding Requirements 2-1
2-10. Installation 2-1
2-12. Rack/Bench Installation 2-1
2-14. Repackaging for Shipment 2-1

Section Page

III OPERATING INSTRUCTIONS 3-1
3-1. Introduction 3-1
3-3. Front Panel Controls 3-1
3-5. General Operating Information 3-1

Section Page

IV THEORY OF OPERATION 4-1
4-1. Introduction 4-1
4-3. Block Diagram Description 4-1
4-16. Detailed Schematic Description 4-1

Section Page

V MAINTENANCE 5-1
5-1. Introduction 5-1
5-3. Test Equipment Required 5-1
5-5. Performance Checks 5-1
5-8. Frequency Response Check 5-1
5-10. Dial Accuracy Check 5-2
5-13. Sine Wave Distortion Check 5-2
5-17. Symmetry Check 5-3
5-20. Square Wave and Pulse Response Checks 5-3
5-26. Output Checks 5-4
5-34. External Frequency Control Check 5-4
5-37. Adjustment and Calibration Procedure 5-4
5-39. Cover Removal 5-5
5-41. Power Supply Adjustment 5-5
5-44. Triangle Amplifier Bias Adjustment 5-5
5-46. Symmetry Adjustment 5-5
5-50. Dial Calibration 5-5
5-53. Frequency Calibration 5-5
5-61. Distortion Adjustment 5-6
5-63. Frequency Response Adjustment 5-6
5-65. Troubleshooting 5-6
5-67. Front Panel Troubleshooting 5-6
5-69. Repair Procedures 5-6

Section Page

VI REPLACEABLE PARTS 6-1
6-1. Introduction 6-1
6-4. Ordering Information 6-1
6-6. Non-Listed Parts 6-1

Section Page

VII SCHEMATIC DIAGRAMS 7-1
7-1. Introduction 7-1
7-3. Functional Block Diagram 7-1
7-5. Schematic Diagrams 7-1
7-7. Component Location Diagrams 7-1

APPENDICES
A. CODE LIST OF MANUFACTURERS
B. SALES AND SERVICE OFFICES
C. MANUAL BACKDATING CHANGES

LIST OF TABLES

Number Page

1-1. Specifications 1-0
5-1. Required Test Equipment 5-0
5-2. Dial Accuracy Check 5-2
5-3. Pulse and Ramp Dial Accuracy 5-2
6-1. Replaceable Parts 6-2

LIST OF ILLUSTRATIONS

Number Page

1-1. Model 3310A Function Generator 1-1
3-1. Front Panel Controls 3-0
4-1. Simplified Block Diagram 4-0
5-1. Frequency Response Check 5-1
5-2. Dial Accuracy Check 5-2
5-3. Distortion Check 5-3
5-4. 5MHz Distortion Check 5-3
5-5. Rise Time Check 5-4
5-6. Output Check 5-4
5-7. External Frequency Control Check 5-5
5-8. Chassis Mounted Components 5-7
7-1. Functional Block Diagram 7-3/7-4
7-2. Tuning and Inverting Amplifiers, Current Sources 7-5/7-6
7-3. Triangle and Feedback Amplifiers, Level Detectors 7-7/7-8
7-4. Sine Shaping and Output Circuits 7-9/7-10
7-5. Power Supply 7-11

Table 1-1. Specifications

FUNCTIONS

Waveforms: sine, square, triangle, positive pulse, negative pulse, positive ramp, and negative ramp. Pulses and ramps have 15% or 85% duty cycle.

PERFORMANCE CHARACTERISTICS

Frequency range: 0.0005Hz to 5MHz in decade ranges.

Sine wave frequency response: reference, 1kHz at full output into 50 ohms.
0.0005Hz to 50kHz: ±1%
50kHz to 5MHz: ±3%

Dial accuracy:
0.0005Hz to 500kHz, all functions: ±(1% of setting +1% of full scale).
500kHz to 5MHz, sine, square, triangle: ±(3% of setting +3% of full scale).
500kHz to 5MHz, pulse and ramp: ±(10% of setting +1% of full scale).

Sine wave distortion (below fundamental):
0.0005Hz to 10Hz: greater than 40dB (1%)
10Hz to 50kHz: greater than 46dB (0.5%)
50kHz to 500kHz: greater than 40dB (1%)
500kHz to 5MHz: greater than 30dB (3%)

Triangle symmetry:
0.0005Hz to 20Hz: less than 1%
20Hz to 50kHz: less than 0.5%

Triangle and ramp linearity:
0.0005Hz to 50kHz: less than 1%.

Square wave and pulse response:
less than 30ns rise and fall times at full output.
less than 35ns rise and fall times at less than full output.
less than 5% total aberration.

Sync output response:
less than 20ns rise and fall times.

OUTPUT CHARACTERISTICS

Maximum HIGH output (except pulses greater than 2MHz):
greater than 30V p-p open circuit.
greater than 15V p-p into 50 ohms.

Maximum HIGH output (pulses greater than 2MHz):
greater than 24V p-p open circuit
greater than 12V p-p into 50 ohms

Minimum LOW output:
less than 30mV p-p open circuit.
less than 15mV p-p into 50 ohms.

LOW output: 30dB below HIGH output for any amplitude setting, when LOW and HIGH are equally terminated.

OUTPUT LEVEL control: greater than 30dB range controlling HIGH and LOW outputs.

SYNC output amplitude:
greater than 4V p-p open circuit.
greater than 2V p-p into 50 ohms.

SYNC waveform: square wave for symmetrical functions, pulse for pulse and ramp functions.

Output impedances:
HIGH: 50 ohms
LOW: 50 ohms
SYNC: 50 ohms

DC Offset:
Amplitude: ±10V open circuit, ±5V into 50 ohms, continuously adjustable.
NOTE: maximum (Vacp + Vdc) is ±15V open circuit, ±7.5V into 50 ohms.

EXTERNAL FREQUENCY CONTROL

Range: 50:1 on any range.

Input requirements:
0 to +10V ±1V for 50:1 increase.
0 to -10V ±1V for 50:1 decrease.
An ac voltage will FM the frequency about a dial setting within the limits ($1 > f < 50$) X range knob setting.

Sensitivity: 100mV/minor division.

Input impedance: 10 kilohms.

GENERAL

Power requirements: 115V or 230V ±10%, 48Hz to 440Hz, less than 20W.

Operating temperature: 0 to 55° C.

Accessories available:
Combining case: HP 1051A
Rack adapter: HP 5060-0797
Filler strip: HP 5060-0105

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information about the -hp- Model 3310A Function Generator. The description of the instrument, its specifications, and instrument identification information are included. Throughout this manual, the Model 3310A will be referred to as the 3310A.

1-3. SPECIFICATIONS.

1-4. Table 1-1 of this section contains the specifications for the 3310A. To verify that the 3310A is operating within these specifications refer to the Performance Checks found in Section V of this manual.

1-5. DESCRIPTION.

1-6. The -hp- Model 3310A Function Generator is a versatile function generator having sine, triangle and square wave outputs, as well as positive-and negative-going pulses and positive-and negative-going ramps. All of these functions have a maximum output amplitude of 30V p-p. Any of these functions may be internally dc offset up to + or -10V. The sum of the dc component plus the peak value of the signal may not exceed 15V into open circuit. A LOW output connector provides a signal level 30dB below the HIGH output. With the 30dB variable attenuator, a total attenuation of greater than 60dB is available.

1-7. The frequency range of the 3310A is from .0005Hz to 5MHz, in 10 ranges. The frequency may be externally controlled, up to a 50:1 range, by an external voltage.

1-8. In addition to the HIGH and LOW outputs, a SYNC OUTPUT is available. This sync signal is a square wave in the Sine, Square, and Triangle functions, and is a pulse in the Ramp and Pulse functions.

1-9. INSTRUMENT AND MANUAL IDENTIFICATION.

1-10. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument within this series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured. If the serial prefix of your instrument differs from the one on the title page of this manual, a change sheet will be supplied to make this manual compatable with newer instruments or the backdating information in Appendix C will adapt this manual to earlier instruments. All correspondence with Hewlett-Packard should include the complete serial number.

1-11. CHANGE SHEETS AND BACKDATING.

1-12. If the serial prefix of your instrument is greater than

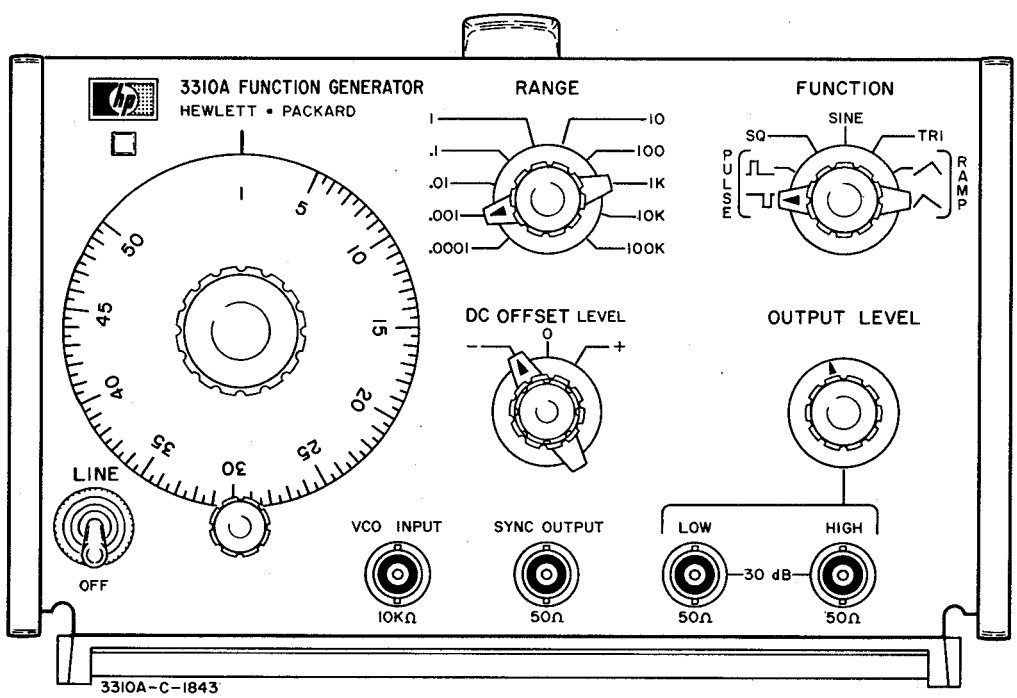


Figure 1-1. Model 3310A Function Generator

the one listed on the title page of this manual, a change sheet will be supplied. The change sheet is included to correct errors in the manual (ERRATA) and to make the manual compatable with instruments manufactured after the printing date of this manual.

1-13. If the serial prefix of your instrument is smaller than the one listed on the title page, the backdating sheet will modify the manual to cover your instrument.

1-14. When necessary, change sheets and backdating information will also contain information regarding changes in instruments with the same serial prefix.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section includes information and instructions necessary for the installation or shipment of this instrument. Included is information pertaining to initial inspection, installation, and repackaging for shipment.

2-3. INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage. Also, the electrical performance of the instrument should be tested using the procedure outlined in Section V of this manual. If there is damage or deficiency, see the warranty at the front of this manual.

2-5. POWER REQUIREMENTS.

2-6. This instrument will operate from either 115 or 230Vac, 48Hz to 440Hz. The instrument can easily be converted from 115 volt to 230 volt operation by changing the position of the slide switch located on the rear panel, so that the designation appearing on the switch matches the nominal voltage of the power source.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. Each Hewlett-Packard instrument is equipped with a three-conductor power cord which, when plugged into an appropriate receptacle grounds the instrument. The offset pin on the power cord three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-10. INSTALLATION.

2-11. This instrument is fully transistorized; therefore no special cooling is required. However, the instrument should not be operated where the ambient temperature is outside the limits specified in Table 1-1.

2-12. RACK/BENCH INSTALLATION.

2-13. This instrument is initially shipped as a bench-type instrument with plastic feet and tilt stand in place. This instrument can be rack mounted by using a rack mounting kit available at your nearest -hp- Sales and Service Office.

2-14. REPACKAGING FOR SHIPMENT.

2-15. The following is a general guide for repackaging for shipment. If you have any question, contact your local -hp- Sales and Service Office. (See Appendix at the back of this manual for office location.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number and serial number prefix.

2-16. Place the instrument in its original container if available. If the original container is not available, a suitable one can be purchased from your nearest -hp- Sales and Service Office.

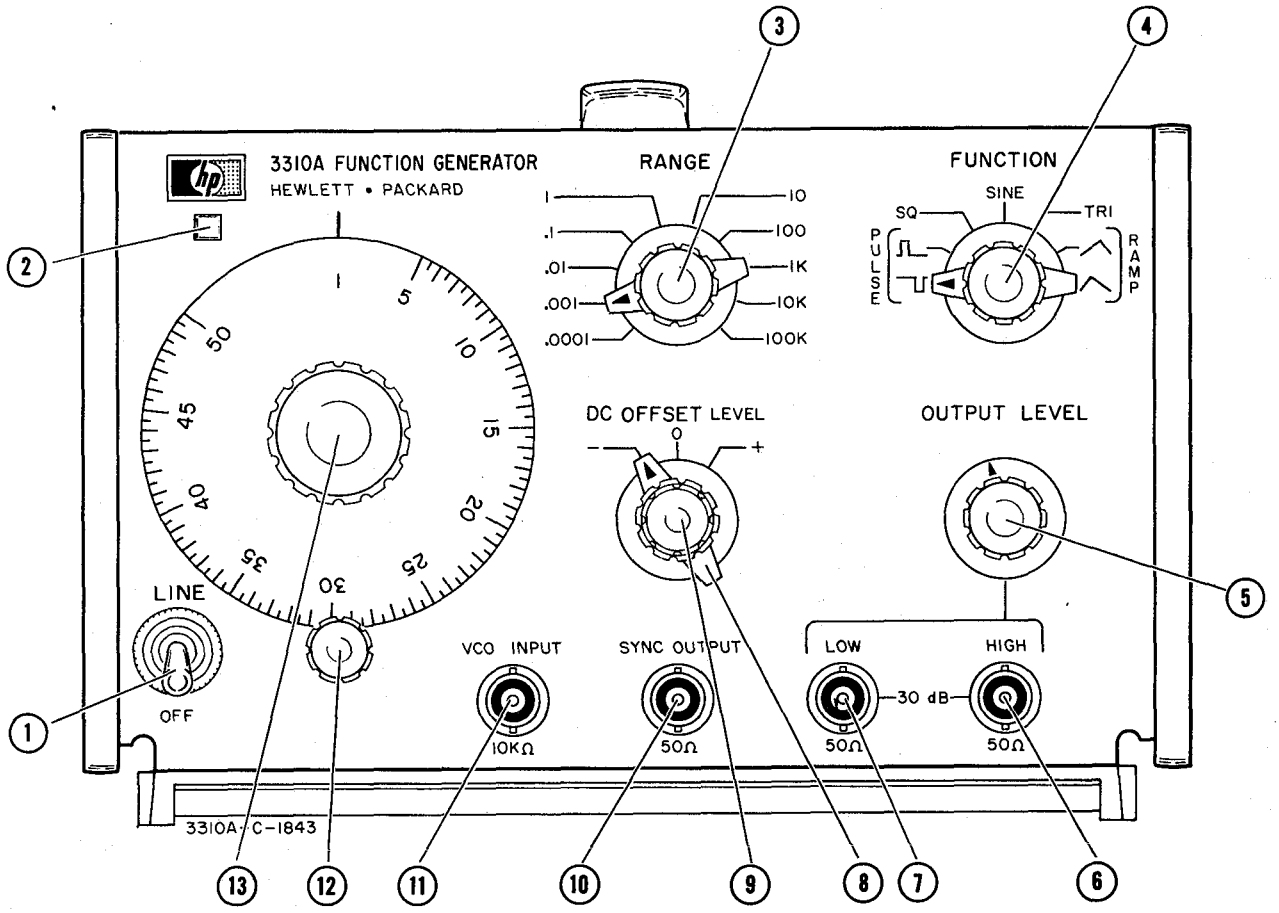
2-17. If the original container is not used:

a. Wrap the instrument in heavy paper or plastic before placing in an inner container.

b. Use plenty of packing material around all sides of the instrument and protect panel faces with cardboard strips.

c. Place the instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark the shipping container with "DELICATE INSTRUMENT," "FRAGILE" etc.



(1) LINE: Power on/off switch.

(2) Pilot Indicator: Glows when instrument is turned on.

(3) RANGE: Selects frequency range multiplier.

(4) FUNCTION: Selects desired function.

(5) OUTPUT LEVEL: Variable attenuator with greater than 30dB dynamic range, controlling both HIGH and LOW outputs.

(6) HIGH Output: Output for all functions, maximum output is 30V p-p.

(7) LOW Output: Output for all functions, signal level is 30dB below HIGH output level, when both outputs are equally terminated.

(8) DC OFFSET Switch: Switches in positive or negative dc offset voltage.

(9) DC OFFSET LEVEL: Adjusts positive or negative dc offset voltage from 0V to 10V.

(10) SYNC OUTPUT: Sync output supplying square wave in Sine, Triangle, and Square functions; pulse in PULSE and RAMP functions.

(11) VCO INPUT: External voltage input for external frequency control. Positive voltage increases frequency from dial setting. Negative voltage decreases frequency from dial setting.

(12) Frequency Vernier: Frequency fine adjust.

(13) Frequency Dial: Frequency coarse adjust.

Figure 3-1. Front Panel Controls

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains information necessary for operation of the Model 3310A Function Generator.

3-3. FRONT PANEL CONTROLS.

3-4. The 3310A front panel controls and connectors are identified and described in Figure 3-1.

3-5. GENERAL OPERATING INFORMATION.

3-6. Any frequency between 0.0005Hz and 5MHz may be chosen using the Frequency Dial setting multiplied by the RANGE multiplier.

3-7. The signal output at both HIGH and LOW outputs may be chosen with the FUNCTION Switch. Available waveforms include sine, square, and triangle waves, as well as positive- and negative-going pulses and positive- and negative-going ramps. Both HIGH and LOW outputs are controlled by the OUTPUT LEVEL control. The LOW output is always 30dB below the HIGH output level when both are equally terminated.

3-8. The HIGH output signal may be dc offset by +/-10V into open circuit, or +/-5V into 50 ohms. When the dc offset is used, the OUTPUT LEVEL must be reduced to prevent distortion of the signal. The sum of the dc offset and the peak value of the signal must not exceed 15Vp into open circuit or 7.5Vp into 50 ohms.

3-9. The SYNC OUTPUT is a dc coupled signal which is a square wave in SQ, SINE, and TRI functions, and a pulse in PULSE and RAMP functions. The sync signal is inverted from the output signal.

3-10. The 3310A frequency may be externally controlled over a range up to 50:1. By setting the Frequency Dial to 1 at the low limit, the full 50:1 increase in frequency may be obtained by applying +10Vdc to the VCO INPUT. By setting the Frequency Dial to 50 and applying -10Vdc, a 50:1 decrease in frequency may be obtained. Any other frequency setting may be frequency modulated by less than 10V p-p ac voltage applied to the VCO INPUT.

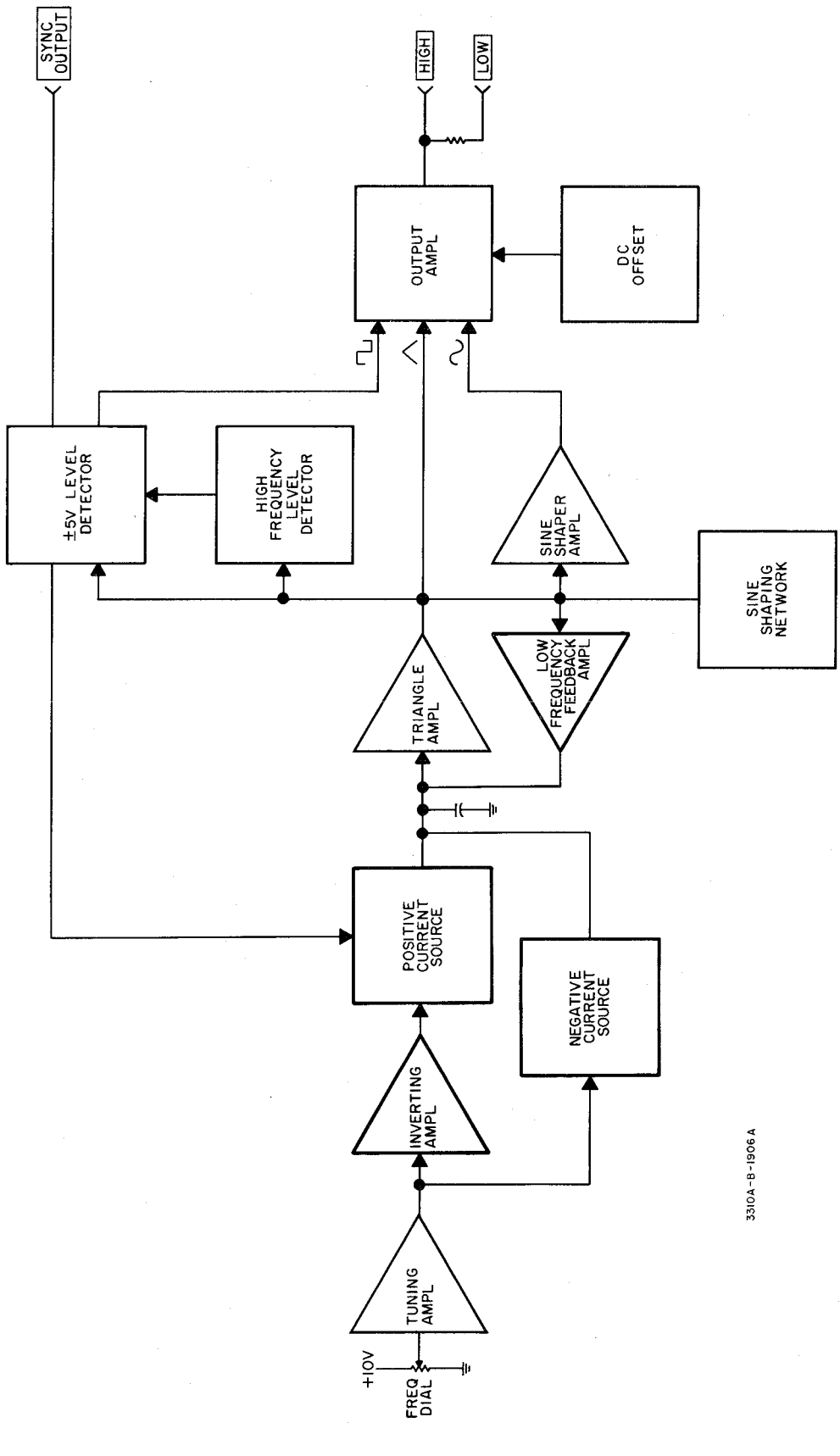


Figure 4-0. Simplified Block Diagram

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section contains a simplified block diagram of the 3310A, a discussion of the theory of operation relating to the simplified block diagram, and detailed schematic theory of operation referring to Figures 7-1 through 7-5.

4-3. BLOCK DIAGRAM DESCRIPTION.

4-4. This description refers to Figure 4-0, Simplified Block Diagram. A detailed Functional Block Diagram is found in Section VII of this manual.

4-5. This instrument is primarily a voltage to frequency conversion device. The Frequency Dial controls a potentiometer which supplies between 0V and 9.0Vdc to the Tuning Amplifier. The Tuning Amplifier is an inverting amplifier with a gain of approximately two. The output of the tuning amplifier is coupled to a negative current source and to the Inverting Amplifier, which has a gain of one. The output of the Inverting Amplifier is coupled to a positive current source.

4-6. The input for the Triangle Amplifier is taken across an integrating capacitor. Current from a positive voltage source (positive current) first charges the capacitor. The capacitor is then discharged to a negative voltage source (negative current). In the symmetrical functions SQ, SINE, and TRI the positive current is equal to the negative current. In the asymmetrical RAMP and PULSE functions, the positive and negative currents are unequal. The currents are reversed when the output of the triangle amplifier reaches either + or -5 volts as detected by the +/-5 Volt Level Detector.

4-7. The positive current source linearly charges the integrating capacitance in a positive direction. This linearly changing voltage is the input to the Triangle Amplifier, causing the voltage output of the Triangle Amplifier to change linearly in a positive direction. When the output reaches +5 volts, the +/-5 Volt Level Detector flips, and the negative current source begins to linearly discharge the integrating capacitance. As the integrating capacitance is discharged, the Triangle Amplifier output continues in a negative direction until it reaches -5 volts. At -5 volts the +/-5 Volt Level Detector flips, and one cycle of the triangle wave is complete.

4-8. The time required to charge and discharge the integrating capacitance determines the period of one cycle and therefore the frequency. The charge time may be changed by varying either the integrating current or the integrating capacitance.

4-9. On the X10 range and higher, the integrating capacitance value changes as the RANGE is switched. The Frequency Dial varies the integrating current at all frequencies. On the .1 range and below, the Low Frequency Feedback Amplifier supplies an opposing integrating current. The amount supplied depends upon the RANGE position.

4-10. At frequencies above 50kHz, the High Frequency Level Detector prevents overshoot in the +/-5 Volt Level Detector. To maintain high frequency accuracy it is necessary to flip the +/-5 Volt Level Detector before the 5 volt level is reached. The High Frequency Level Detector determines how early the flip must take place to correct for loop delay.

4-11. The output of the +/-5 Volt Level Detector is a square wave which, when amplified by the Output Amplifier, becomes the square wave output.

4-12. The output of the Triangle Amplifier is also coupled to the Sine Shaping Network and the Sine Shaper Amplifier. The triangle wave is synthesized into a sine wave by the Sine Shaping Network, and this sine wave is amplified by the Sine Shaper Amplifier. The output of the Sine Shaper Amplifier, when amplified by the Output Amplifier, becomes the sine wave output.

4-13. The outputs of the +/-5 Volt Level Detector, the Sine Shaper Amplifier, and the Triangle Amplifier are amplified by the Output Amplifier. A dc voltage may be summed with any of the inputs to the Output Amplifier to produce a dc offset output.

4-14. The output of the +/-5 Volt Level Detector provides the SYNC OUTPUT signal. This Sync Output signal is a square wave in SINE, SQ, and TRI. In the pulse and ramp functions it is a pulse.

4-15. The Output Amplifier supplies the chosen signal to the HIGH output connector. The same signal is attenuated 30dB and is available at the LOW output connector.

4-16. DETAILED SCHEMATIC DESCRIPTION.

4-17. The following paragraphs refer to Figures 7-1 and 7-2.

4-18. The Tuning Amplifier consists of A1IC1 and A1Q1. It is an operational amplifier, using feedback through A1R11. The input to the Tuning Amplifier is a summing junction which sums the voltage from the VCO INPUT with the voltage from the Frequency Dial potentiometer R1. Variable resistors A1R1 through A1R5 provide fine adjustment for each frequency range from .1 to 100K. The

output of the Tuning Amplifier is coupled to the input of the Inverting Amplifier and to the negative Current Source A1Q6.

4-19. The Inverting Amplifier consists of A1IC2 and A1Q2. It has a gain of one and inverts the voltage. The output of the Inverting Amplifier is coupled to the positive Current Source.

4-20. The inputs to both current sources are coupled through the FUNCTION switch A2S3. In sine, square, and triangle functions, the resistors A2R1 and A2R4 control the amount of current in the current sources. If the amount of current flowing in the negative current source A1Q6 is equal to i, then a current of 2i is flowing in the positive current source. The output of positive current source A1Q5 is gated on by the +/-5 Volt Level Detector during the positive portion of the Triangle Amplifier output.

4-21. Since A1Q5 is supplying current equal to 2i, and A1Q6 is supplying a negative current equal to i, a positive current equal to i is coupled to the integrating capacitance at the Triangle Amplifier input. When the Triangle Amplifier output reaches +5 volts, the +/-5 Volt Detector changes state. A negative gate is coupled to A1CR4, terminating the positive 2i current from A1Q5. Since the negative current i is still flowing in A1Q6, this negative current i discharges the integrating capacitance. This condition exists until the output of the Triangle Amplifier reaches -5 volts, at which time the positive current 2i is gated on again. This completes one cycle of the oscillation.

4-22. In the pulse and ramp functions, asymmetrical values of positive and negative current flow. These different values of current determine an 85% or 15% duty cycle.

4-23. The feedback through A1R10 to the Tuning Amplifier input corrects for changes in characteristics in A1Q5 and A1Q6 and avoids frequency error.

4-24. The Bias Network consists of A1Q3 and A1Q4, and corrects for the individual differences between A1Q5 and A1Q6 and keeps their emitter voltages at the correct levels to avoid symmetry error.

4-25. The following paragraphs refer to Figures 7-1 and 7-3.

4-26. The value of integrating capacitance on the input of the Triangle Amplifier depends upon the position of the RANGE switch. Figure 7-3 shows this switch in the X.0001 position. If the RANGE switch were in the X10 position A1C13, A1C14, and A1C16 would be in parallel with A1C17 to form the total integrating capacitance.

4-27. As the frequency dial is varied, the currents in the current sources vary. The greater the current source outputs, the higher the rate of charge seen at the integrating capacitance, and the shorter the period of each cycle of the Triangle Amplifier.

4-28. The input stage of the Triangle Amplifier is a field effect transistor, A1Q12. This FET has a very high input impedance. A1Q13 is a current source for the FET, and A1R56 is a bias adjustment. The output of the Triangle Amplifier is coupled to the +/-5 Volt Level Detector.

4-29. The output of the Triangle Amplifier is coupled to tunnel diodes A1CR21 and A1CR22. When the triangle output reaches +5 volts A4CR21 conducts, causing the +/-5 Volt Level Detector to change states. When the triangle output reaches -5 volts, A1CR22 conducts, causing the level detector to flip back to its original state. Three parallel output stages furnish the square or rectangular wave outputs.

4-30. The triangle output is also coupled to the High Frequency Level Detector through A1CR13 and A1CR15. On the X10K and X100K ranges, the outputs of the A1Q22 and A1Q26 are coupled to the +/-5 Volt Level Detector.

4-31. As the frequency of the instrument increases above 50kHz, the time required to gate the current source and reverse the triangle output becomes significant. Because of this loop delay, the triangle output begins to go slightly beyond +/-5 volts. This starts to increase the period of each cycle and introduces frequency error.

4-32. As the peak value of the triangle starts to increase, the charge on A1C22 and A1C26 increases. The outputs of A1Q22 and A1Q26 change and the result is a change of bias on the tunnel diodes, causing them to conduct at some level below +/-5 volts. This corrects the condition which would otherwise cause frequency error.

4-33. For ranges X.0001 through X10, the integrating capacitance for the Triangle Amplifier remains the same because of physical size limitations. On these ranges the Low Frequency Feedback Amplifier becomes active. This amplifier, consisting of A1Q44 through A1Q51, supplies a negative feedback current to the integrating capacitance. When the current sources are supplying a positive current, the feedback amplifier is supplying a negative current. When the current sources are supplying a negative current, the feedback amplifier supplies a positive current. The integrating capacitance is then charged with a current equal to the source current minus the feedback current.

4-34. The feedback current changes by a factor of 10 with each change of range switch position. This is accomplished by switching in different values for the feedback resistor. The feedback current is constant for any one frequency.

4-35. The input stage of the feedback amplifier is a differential amplifier using a dual FET. This differential amplifier is referenced to the Triangle Amplifier input.

4-36. The following paragraphs refer to Figures 7-1 and 7-4.

4-37. At the input to the Sine Shaping Network, there is shown a feedback path going to the positive current source.

The feedback capacitor A2C1 is selected to furnish a positive feedback current to the positive current source output that is equal to the amount of current lost through the capacitance of the positive current source transistor at higher frequencies.

4-38. The triangle wave is applied to the Sine Shaping Network through resistor A2R10. The even numbered diodes conduct in shaping of the negative half of the sine wave while the odd numbered diodes conduct in shaping the positive half of the sine wave. Transistors A3Q1 through A3Q6 are constant voltage supplies for the diode shaping network.

4-39. The signal at the input to the Sine Shaper Amplifier is a sine wave. The shaper amplifier is an inverting operational amplifier whose gain is approximately one, as controlled by the input resistor A2R11 and the feedback resistor A2R18.

4-40. The FUNCTION switch S3 is used to couple one of the waveforms to the OUTPUT LEVEL control A2R20. From the center arm of this potentiometer, the signal is coupled through A3R31 to a summing junction. At this summing junction, the signal is summed with the output of the DC OFFSET LEVEL control. Up to +/-10Vdc offset voltage may be coupled through A3R32 to the summing junction.

4-41. The lower frequencies are amplified by A3IC1 and coupled through A3CR28 and A3R36 to the collector of A3Q9. High frequencies are coupled through A3C5 and A3C6 to the bases of A3Q9 and A3Q12. At high frequencies A3C7 couples the signal from A3Q9 collector to A3Q11 emitter.

4-42. The final output transistors Q1 and Q2 complete the complementary symmetrical output stages. A3CR15 through A3CR20 are biasing diodes. A3R69 supplies negative feedback to the input of the amplifier to control the overall gain.

4-43. A3R66 provides 50 ohms resistance for the amplifier HIGH output. R5 attenuates the signal 30dB and R6 provides the 50 ohms resistance for the LOW output.

Table 5-1. Required Test Equipment

Instrument Type	Required Specifications	Recommended Model
Electronic Counter	0.005MHz to 5MHz with time interval capability	-hp- Model 5245L/5262A
Oscilloscope	5MHz Bandwidth	-hp- Model 180A/1801A/1820A
RMS Voltmeter	Accuracy: 2% dB Range: -60dB to +10dB	-hp- Model 3400A
Broadband Sampling Voltmeter	Frequency Range: 1MHz to 50MHz Voltage Range: 0.003V to 3V	-hp- Model 3406A
Digital Voltmeter	Ranges: 10Vdc to 30Vdc with 4 digit presentation	-hp- Model 3439A/3441A
DC Voltmeter	Ranges: 1V to 300V Accuracy: 3%	-hp- Model 427A
DC Power Supply	Range: 0V to 15V continuously variable	-hp- Model 6215A
DC Null Voltmeter	Ranges: ±3uV to ±30mV	-hp- Model 419A
Thermal Converter	Input Impedance: 50 ohms Voltage Input: 5Vrms Frequency Range: 5Hz to 5MHz	-hp- Model 11049A
Feedthrough Terminating Resistance	Resistance: 50 ohms Frequency Range: dc to 5MHz	-hp- Model 11048B
DC Reference Supply	(See Figure 5-1) Resistor: variable 50 ohms Resistor: variable 500 ohms Resistor: fixed 6.5 kilohms Battery: 1.3V	 -hp- Part No. 2100-1481 -hp- Part No. 2100-0324 -hp- Part No. 0811-0392 Mallory RM-42R
5MHz High Pass Filter	(See Figure 5-4) C1 C: fxd 186.7pF C2 C: fxd 140pF C3 C: fxd 209pF C4 C: fxd 2700pF C5 C: fxd 1000pF L1,L2 L: var 0.78-1.25uH	 -hp- Part No. 0140-0148 -hp- Part No. 0140-0217 -hp- Part No. 0140-0109 -hp- Part No. 0160-2228 -hp- Part No. 0140-0179 -hp- Part No. 0140-0061
Pad: 50 ohm matching 4.5dB attenuation	Resistor: fxd 12.7 ohms (2) Resistor: fxd 93.1 ohms	-hp- Part No. 0698-4104 -hp- Part No. 0698-4835

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for proper maintenance and repair of the 3310A. Included are Performance Checks, Adjustment and Calibration Procedures, Troubleshooting information, and Repair Procedures.

5-3. TEST EQUIPMENT REQUIRED.

5-4. Table 5-1 contains information about the test equipment necessary to perform the procedures given in this section. This table includes the types of instruments required, their critical specifications, and recommended models. If the recommended model is not available, any model which meets the critical requirements may be substituted.

5-5. PERFORMANCE CHECKS.

5-6. The Performance Checks are designed to assist in comparing the 3310A with its published specifications. These checks may be used for incoming inspection, periodic maintenance, and after-repair checks. The Performance Checks should be done before any attempt is made to adjust or calibrate the instrument. If the instrument does not meet the requirements outlined in the Performance Checks, refer to the Adjustment and Calibration procedure in this section.

5-7. A Performance Check Test Card is provided at the end of this section for recording the performance of the 3310A during the Performance Checks. The card may be removed from the manual and used as a permanent record if desired.

5-8. FREQUENCY RESPONSE CHECK.

5-9. Connect the equipment as shown in Figure 5-1.

a. Set the 3310A controls for a 1kHz sine wave output.

b. Adjust the 3310A for a full output.

c. Set the null meter to voltmeter function.

d. Adjust the reference supply 50 ohm control for minimum resistance.

e. Record the null meter indication of the thermal converter output.

NOTE

The thermal converter is theoretically a square-law device. The percent of change of output should, therefore, be 2 times the percent of change of the input. The actual factor is less than 2, typically about 1.7. Check the calibration report supplied with your thermal converter for the exact multiplier.

f. Adjust the reference supply 500 ohm and 50 ohm controls for the best null possible. Do not readjust these controls for the remainder of the check.

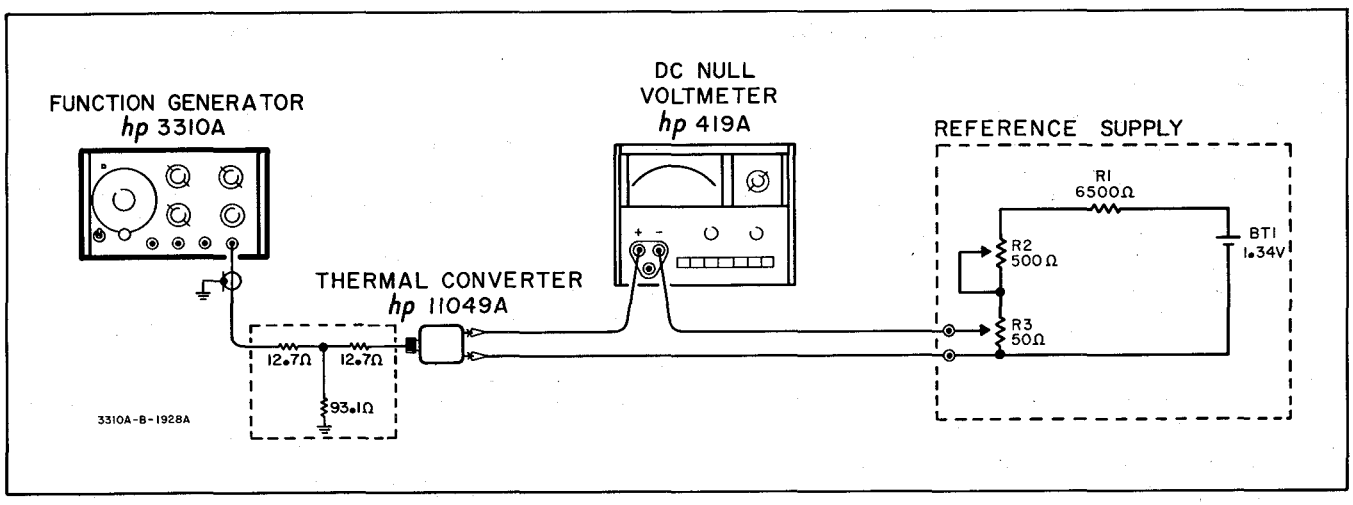


Figure 5-1. Frequency Response Check

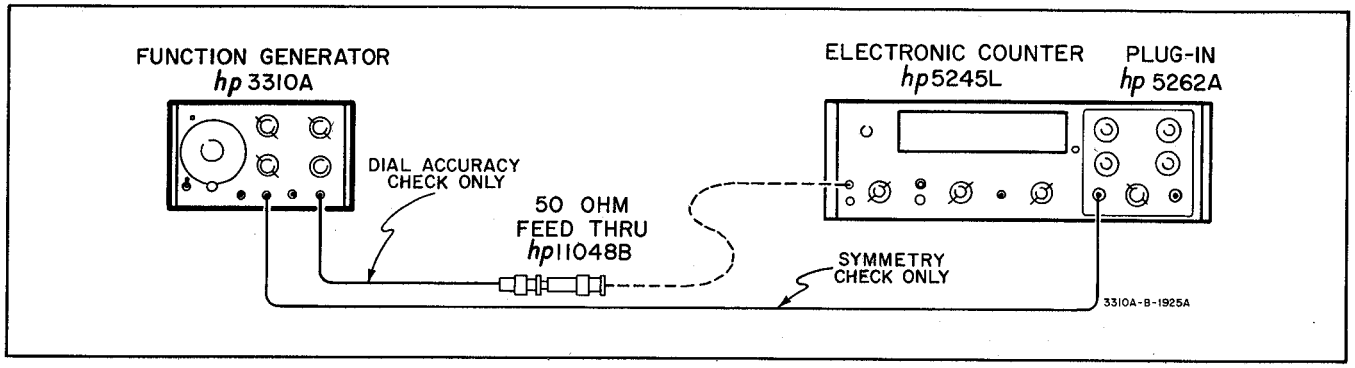


Figure 5-2. Dial Accuracy Check

Table 5-2. Dial Accuracy Check

Dial	Range	Counter Indication
5	.001	180 to 224s
30	.001	32.4 to 34.2s
50	.001	19.6 to 20.4s
5	.01	18.0 to 22.4s
30	.01	3.24 to 3.42s
50	.01	1.96 to 2.04s
5	.1	1.80 to 2.24s
30	.1	324 to 342ms
50	.1	196 to 204ms
5	1	180 to 224ms
30	1	32.4 to 34.2ms
50	1	19.6 to 20.4ms
5	10	18.0 to 22.4ms
30	10	3.24 to 3.42ms
50	10	1.96 to 20.4ms
5	100	1.80 to 2.24ms
30	100	2920 to 3080Hz
50	100	4900 to 5100Hz
5	1K	4450 to 5550Hz
30	1K	29.20kHz to 30.80kHz
50	1K	49.00kHz to 51.00kHz
5	10K	44.50kHz to 55.50kHz
30	10K	292.0kHz to 308.0kHz
50	10K	490.0kHz to 510.0kHz
5	100K	345.0kHz to 655.0kHz
30	100K	2.760MHz to 3.240MHz
50	100K	4.700MHz to 5.300MHz

NOTE

The 3310A output level should be reduced substantially before switching frequency ranges; otherwise, transients may damage the thermal converter. This operation should be performed quickly to prevent the necessity of allowing time for the thermal converter to restabilize.

g. Allowing 5 seconds settling time before reading the null meter, check several frequencies between 5Hz and 50kHz. Maximum allowable null meter reading may be determined by the formula:
Max. reading =
0.01 X temp. conv. output X temp. conv. multiplier
Example:

Max. reading = 0.01 X 7mV X 1.7
= 0.119mV

h. Check several frequencies above 50kHz. Maximum allowable null meter reading may be determined by the formula:
Max. reading =
0.03 X temp. conv. output X temp. conv. multiplier
Example:

Max. reading = 0.03 X 7mV X 1.7
= 0.357mV

5-10. DIAL ACCURACY CHECK.

5-11. Connect the 3310A as shown in Figure 5-2. Set the 3310A for a square wave output. Measure the frequencies or periods shown in Table 5-2. Do not connect the sync output to the plug-in at this time.

5-12. Set the 3310A for a pulse output. Measure the frequencies shown in Table 5-3.

Table 5-3. Pulse and Ramp Dial Accuracy

Dial	Range	Counter Indication
5	100K	400kHz to 600kHz
30	100K	2.65MHz to 3.35MHz
50	100K	4.45MHz to 5.55MHz

5-13. SINE WAVE DISTORTION CHECK.

5-14. Connect the 3310A as shown in Figure 5-3. Set the 3310A to SINE function at 10Hz. Distortion should be more than 46dB below the fundamental. Measure distortion at several frequencies between 10Hz and 50kHz. Distortion should be more than 46dB below the fundamental.

5-15. Measure distortion at several frequencies between 50kHz and 500kHz on the X10K range. Distortion should be more than 40dB below the fundamental.

5-16. Connect the 3310A as shown in Figure 5-4, with the feedthrough termination connected directly to 3310A

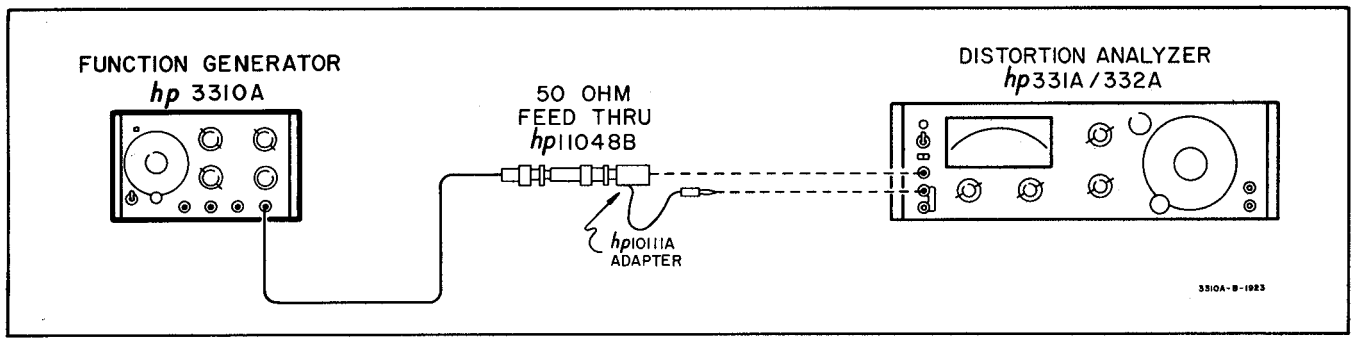


Figure 5-3. Distortion Check

HIGH output. With the 3310A OUTPUT LEVEL fully CCW, record the meter indication in dB. Insert the 5MHz filter between the 3310A and the feedthrough termination. Tune the filter for minimum indication on the voltmeter. The voltmeter indication should be more than 30dB below the recorded reference level.

5-17. SYMMETRY CHECK.

5-18. Set the 3310A function switch to TRI. Connect the SYNC OUTPUT of the 3310A to the time interval input of an electronic counter as shown in Figure 5-2. Do not connect the 3310A output to the electronic counter signal input.

5-19. Symmetry error may be determined by the following formula:

$$E_S = \frac{T_1 - T_2}{T_1 + T_2}$$

where,
T_1 = period of positive transition of waveform
T_2 = period of negative transition of waveform

a. Check symmetry at several frequencies below 20Hz. This value should not exceed 1%.

b. Check symmetry at several frequencies between 20Hz and 50kHz. Symmetry error should not exceed 0.5%.

5-20. SQUARE WAVE AND PULSE RESPONSE CHECKS.

5-21. Connect the 3310A as shown in Figure 5-5. Set the OUTPUT LEVEL fully CW and the function switch to SQ. Check the rise time and fall time at 1kHz. Time required for the transition between 10% and 90% of the square wave

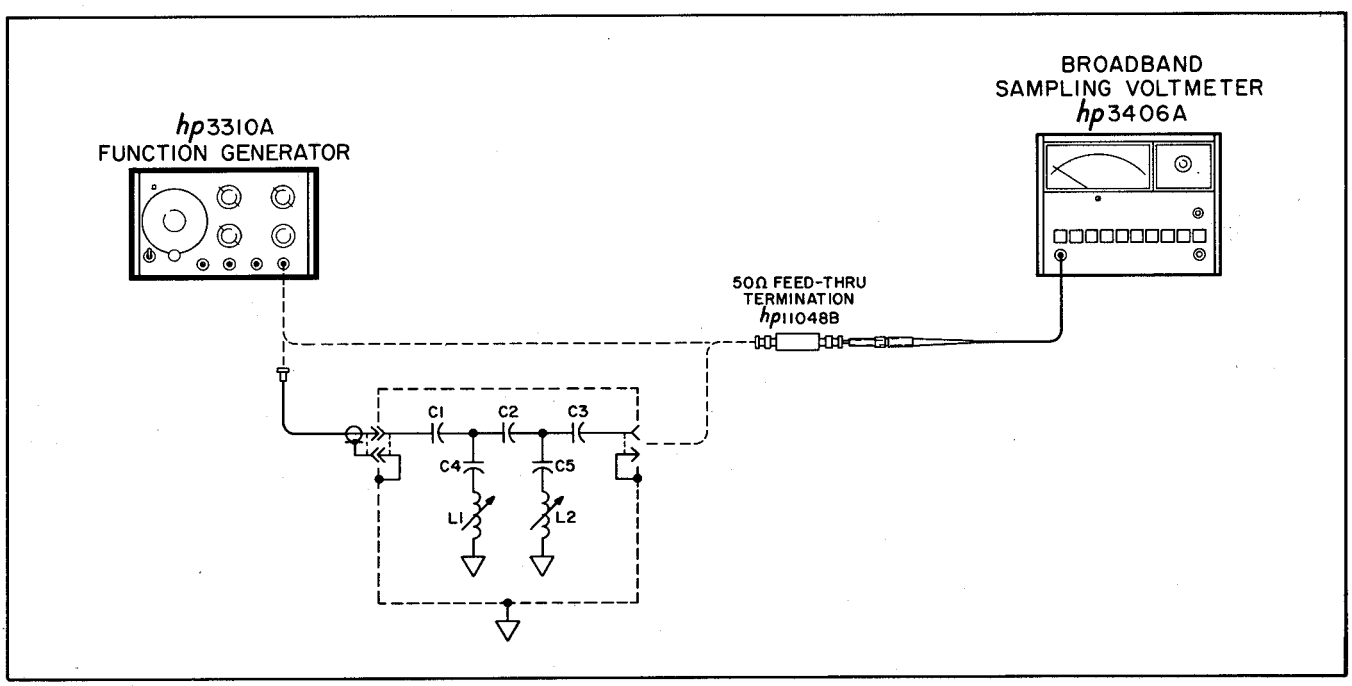


Figure 5-4. 5MHz Distortion Check

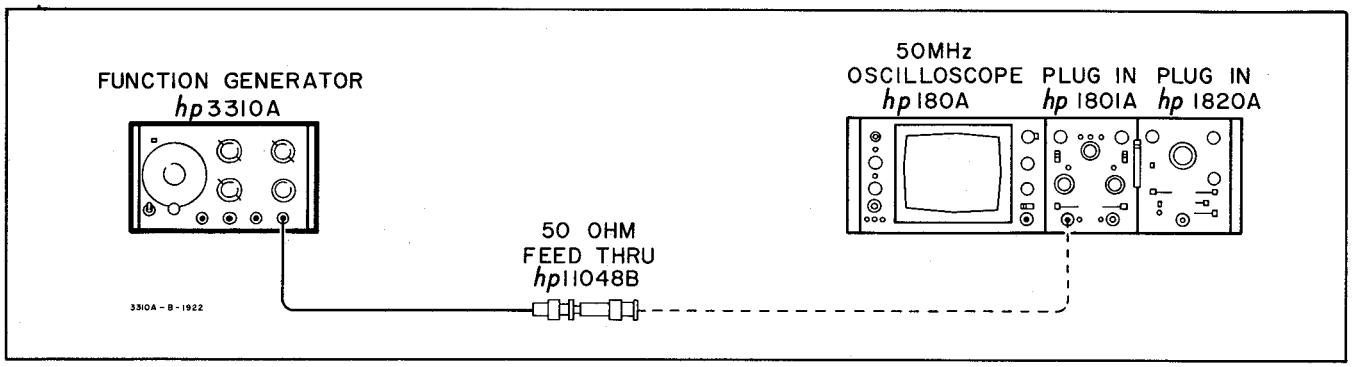


Figure 5-5. Rise Time Check

amplitude should be less than 30ns. Change the function switch to a pulse position. The rise and fall times should still be less than 30ns.

5-22. Repeat the rise and fall time check for both square wave and pulse functions at several other frequencies to assure less than 30ns.

5-23. Reduce the OUTPUT LEVEL to center position. Measure rise and fall times for square waves and pulses at several different frequencies. These rise times should be less than 35ns.

5-24. Observe the aberration of the square wave and pulse outputs at several frequencies. Neither the overshoot nor the sag should exceed 5% of the peak-to-peak value of the signal.

5-25. Measure the rise and fall times of the SYNC output signal in both square wave and pulse functions at several frequencies. The rise and fall times should be less than 20ns.

5-26. OUTPUT CHECKS.

5-27. Connect the 3310A as shown in Figure 5-6, with OUTPUT LEVEL fully CW and the function switch to SINE. The voltmeter indication should be greater than 5.3Vrms. Remove the 50 ohm load and connect the 3310A output directly to the voltmeter. The voltmeter indication should be greater than 10.6Vrms. Record this indication in dB. Turn the OUTPUT LEVEL control fully CCW. The indication should now be greater than 30dB below the recorded indication.

5-28. With the 3310A OUTPUT LEVEL control fully CCW, connect the voltmeter to LOW output jack with no load. The meter indication should be less than 30mV.

5-29. Set the 3310A controls for a 2MHz pulse output. Connect the HIGH output to the oscilloscope input with no load. The pulse should have a peak-to-peak amplitude of greater than 30 volts.

5-30. Set the 3310A controls for a 5MHz pulse output. The open circuit peak-to-peak amplitude should be greater than 24 volts.

5-31. Connect the SYNC output to the oscilloscope without a load. Set the 3310A controls for a 5MHz sine wave output. The peak-to-peak amplitude of the sync signal should be greater than 4 volts. With a 50 ohm load the amplitude should be greater than 2 volts.

5-32. Connect the HIGH output to the oscilloscope, and set the 3310A for a 1kHz square wave output. With the OUTPUT LEVEL fully CCW, vary the DC OFFSET in both positive and negative directions. Maximum dc offset should be greater than ±10V open circuit.

5-33. Set the DC OFFSET control for +5 volts offset. Adjust the OUTPUT LEVEL control for a maximum sine wave output without distortion. The positive peak of the sine wave (Vacp + Vdc) should be greater than 15V open circuit.

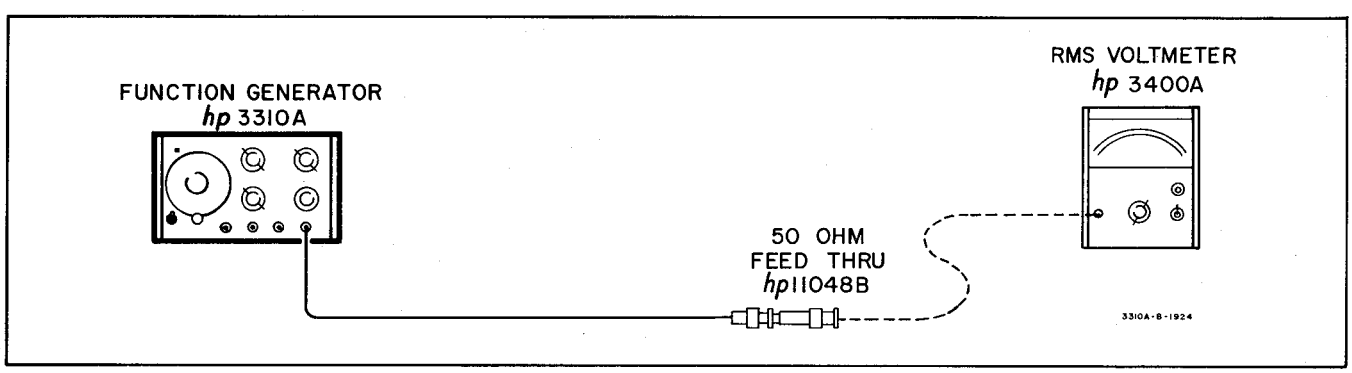


Figure 5-6. Output Check

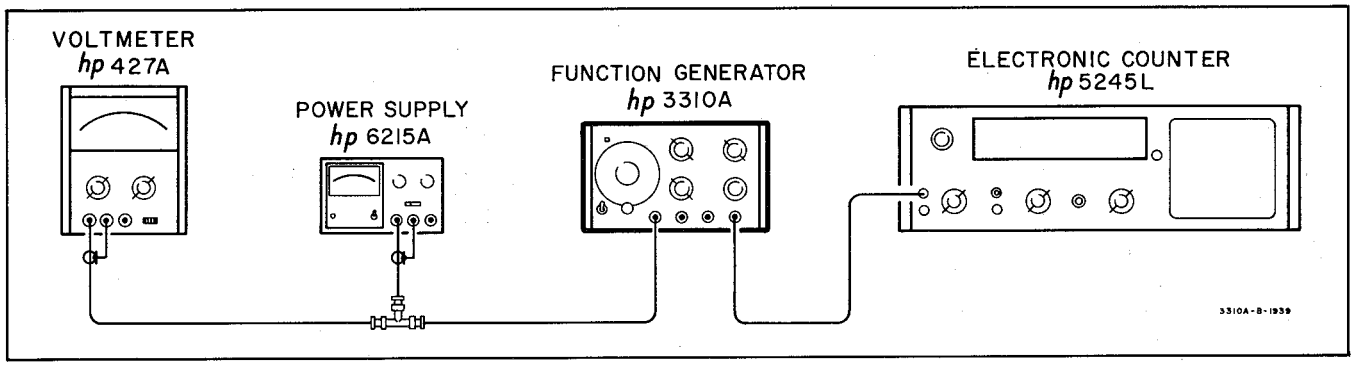


Figure 5-7. External Frequency Control Check

5-34. EXTERNAL FREQUENCY CONTROL CHECK.

5-35. Connect the 3310A as shown in Figure 5-7. Set the 3310A to the X1K range and the OUTPUT LEVEL control to mid-position. Adjust the Frequency Dial until the counter indicates 50.0kHz with the VCO input disconnected. Then connect the VCO input and adjust the power supply for a negative dc output. Increase the negative dc output until the counter indicates 1.0kHz. The dc voltage should be -10V ±1.0V.

5-36. With the VCO input disconnected, adjust the Frequency Dial for a counter indication of 1.0kHz. Apply a positive dc voltage until the counter reads 50.0kHz. The dc voltage should be +10V ±1.0V.

5-37. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-38. The following paragraphs contain a complete adjustment and calibration procedure for the Model 3310A. This procedure should be performed only if it has been determined by the Performance Checks that the instrument is not operating within the published specifications. Voltage measurements are referenced to chassis ground.

5-39. COVER REMOVAL.

5-40. To remove the top or bottom cover, remove the screws, slide the cover to the rear, and lift off. A side cover may be removed by removing the screws and lifting the cover off.

5-41. POWER SUPPLY ADJUSTMENT.

5-42. Connect the 3310A to the 115V line and turn the instrument on. Connect the digital voltmeter to A4 Pin 3 and proceed with the following.

a. Adjust A3R101 for +10.00V ±10mV.

b. Measure A3 Pin 5 to confirm -10.00V ±50mV.

c. Measure A3TP1 to confirm +25.0V ±1.0V.

d. Measure A3TP3 to confirm -25.0V ±1.0V.

5-43. If any of the last three voltage measurements are out of tolerance, troubleshoot the power supply before trying to perform further adjustment and calibration.

5-44. TRIANGLE AMPLIFIER BIAS ADJUSTMENT.

5-45. Set the 3310A controls to the X10 range and square wave function. Connect the oscilloscope to the front end of A1C16 and adjust A1R56 until the positive peak of the triangle is at 0V +/-0.1V.

5-46. SYMMETRY ADJUSTMENT.

5-47. Connect the SYNC output of the 3310A to the input of the time interval counter as shown in Figure 5-2. Set the 3310A range to 100, the dial to 50, and the function to SQ. Measure the time interval of each half cycle. Adjust A1R24 until the time intervals for both half cycles are within 10us of each other.

5-48. Set the 3310A dial to 5 and adjust A1R26 until the time intervals for both half cycles are within 100us of each other.

NOTE

A1R24 and A1R26 interact. It may be necessary to repeat these adjustments to achieve symmetry at both ends of the dial.

5-49. Set the 3310A frequency dial to 5 and the range to the X1 position. Adjust A1R162 for best symmetry. Set the dial to 50 and assure that the time intervals are within 200ms of each other. If not, repeat all steps of this symmetry adjustment.

5-50. DIAL CALIBRATION.

5-51. Connect the digital voltmeter to the center terminal of the 3310A frequency dial tuning potentiometer. Set the frequency dial to 5, and confirm that the digital voltmeter reads between 850mV and 950mV. If not, the dial should be slipped by loosening its set screws until a reading of 850mV to 950mV is obtained at the 5 setting. The center terminal should be between 100 and 170mV when the frequency is at its lower limit.

5-52. With the frequency dial set to 5, measure and record the center terminal voltage reading. Subtract 900mV from this reading and record the difference. Adjust A1R17 for a reading at A1TP1 equal to the difference voltage above. For example if the center terminal voltage is 875mV, A1R17 should be adjusted so that A1TP1 reads -25mV (875mV - 900mV).

5-53. FREQUENCY CALIBRATION.

5-54. Connect the SYNC output of the 3310A to counter. Set the 3310A dial to 50, the RANGE to X100K, and the function switch to sine. Adjust A1R6 for a 5.00MHz ±20kHz indication.

5-55. Change the 3310A RANGE to X10K. Adjust A1R5 for an indication of 500kHz ±2kHz.

5-56. Change the 3310A RANGE to X1K and adjust A1R4 for an indication of 50kHz ±200Hz.

5-57. Change the 3310A function switch fully CW to the negative ramp position. Adjust A2R6 for a reading of 50kHz +/-200Hz.

5-58. Change the 3310A function back to sine wave and the RANGE to X100. Adjust A1R3 for an indication of 5000Hz ±20Hz.

5-59. Change the 3310A RANGE to X10 and adjust A1R2 for an indication of 2000us ±10us.

5-60. Change the 3310A RANGE to X1 and adjust A1R1 for an indication of 20,000us ±100us.

5-61. DISTORTION ADJUSTMENT.

5-62. Set the 3310A RANGE to X100, the Dial to 50, and the function switch to SINE. Using a 50 ohm load, connect the HIGH output of the 3310A to the distortion analyzer. Adjust A3R4 and A3R27 for best distortion readings. The distortion measurement should be greater than 46dB below the fundamental.

5-63. FREQUENCY RESPONSE ADJUSTMENT.

5-64. Connect the 3310A as shown in Figure 5-1. Using the procedure in Paragraph 5-9, determine the maximum frequency response variation on the top frequency range. Adjust A2C3 for best frequency response with maximum variation from the reference level being less than ±3%.

5-65. TROUBLESHOOTING.

5-66. The following paragraphs refer to Figure 7-1, Functional Block Diagram, and Figures 7-2 through 7-5.

5-67. FRONT PANEL TROUBLESHOOTING.

5-68. The Front Panel Troubleshooting procedure is useful in isolating a problem which causes the 3310A to stop oscillating or to have very abnormal waveforms. Intermittent problems may be overlooked in this procedure.

a. Set the 3310A controls for a 100Hz triangle wave output. Connect the HIGH output to an oscilloscope, and set the OUTPUT LEVEL fully CW. If a 100Hz triangle wave is observed on the oscilloscope, go to step b. If not, go to step i.

b. Change the 3310A to sine function. If a 100Hz sine wave is observed, go to step c. If not, go to step h.

c. Change the 3310A RANGE to X100 and the function to triangle wave output. If the triangle wave is normal, go to step d. If not, go to step i.

d. Change the 3310A RANGE to X1K. If the triangle wave is normal, go to step e. If not, go to step i.

e. Check for proper output on X10K and X100K ranges. If normal, go to step f. If not, go to step g.

f. Check for proper output on the X.1 range. If normal, check the X.01, X.001, and X.0001 ranges. If any of these ranges have problems, troubleshoot the Low Frequency Feedback Amplifier.

g. If only the X10K and X100K have abnormal operation, troubleshoot the High Frequency Level Detector.

h. If square and triangle outputs are normal and the sine wave is abnormal, troubleshoot the Sine Shaping Network and the Sine Shaper Amplifier.

i. If the triangle wave output is abnormal on the X10, X100, or X1K range, a number of circuits could be responsible. Set the RANGE to X10 and switch in +DC OFFSET. While monitoring the HIGH output with a dc voltmeter, vary the dc offset from limit to limit. If a 10 volt variation is observed, go to step j. If not, troubleshoot the Output Amplifier.

j. Set the Frequency Dial to 50 and connect -5Vdc to the VCO input. If the output is normal with the -5V input and there is no output when the VCO input is removed, troubleshoot the Frequency Dial potentiometer and Range switch. Otherwise troubleshoot the Tuning Amplifier, Current Sources, Triangle Amplifier, and +/-5 Volt Level Detector. Figures 7-2 through 7-5 show dc voltage levels to aid in troubleshooting.

5-69. REPAIR PROCEDURES.

5-70. The A1 assembly may be removed from the instrument by removing the RANGE knob and one screw

holding in the pc board. The other pc board assemblies should be repaired in the instrument when possible. It is necessary to disassemble most of the instrument to remove the other pc boards.

5-71. Multi-layer pc boards are used in this instrument. They should be handled very carefully to avoid damage. Bending a multi-layer pc board may cause broken internal traces.

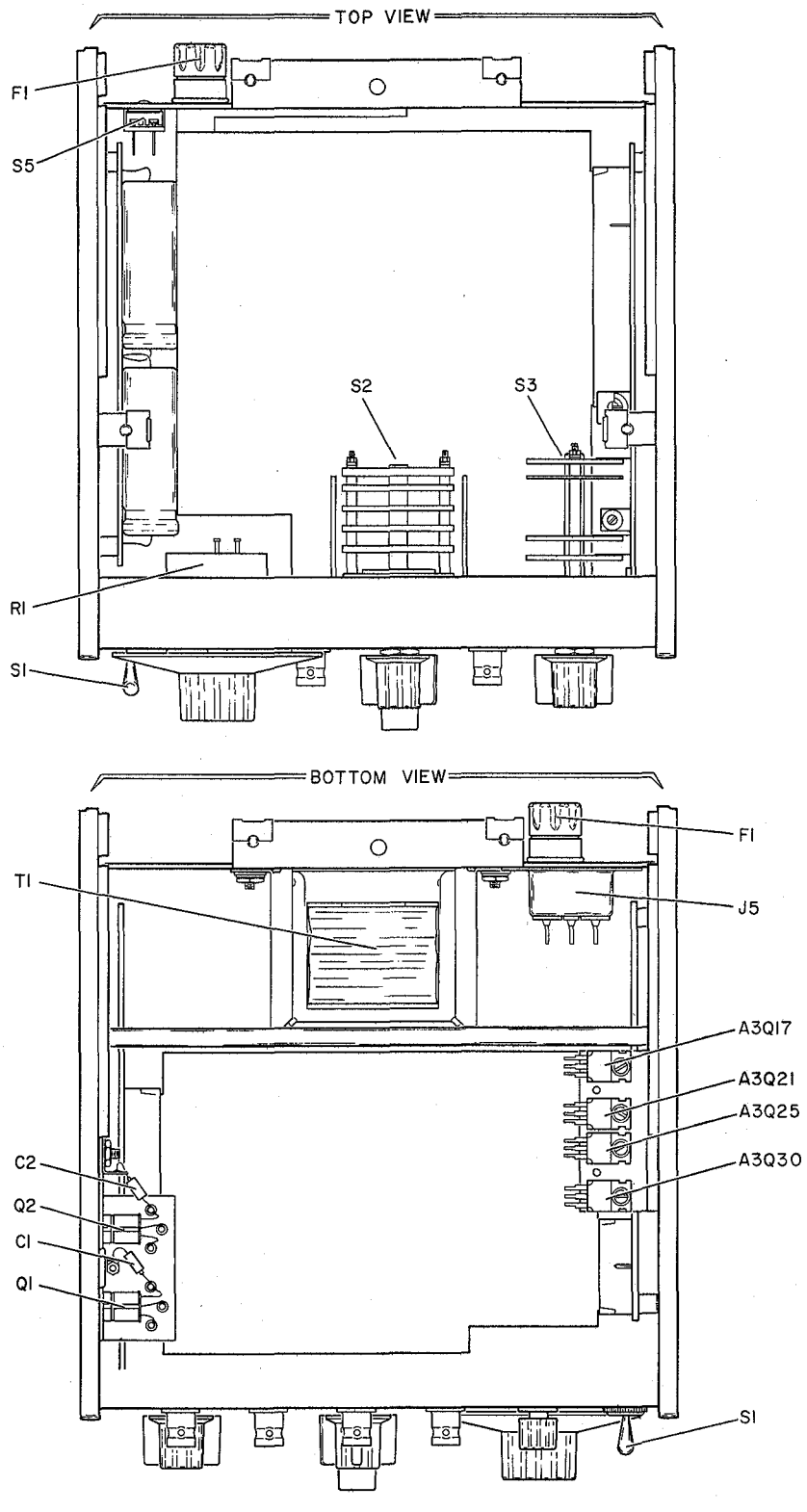


Figure 5-8. Chassis Mounted Components

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 3310A
Function Generator
Serial No. _____

Tests Performed By _____
Date _____

Description	Check
Frequency Response Check	
5Hz to 50kHz	± 1% _____
50kHz to 5MHz	± 3% _____
Dial Accuracy Check	
Dial / Range	Counter Indication
5 / .001	180 to 224s _____
30 / .001	32.4 to 34.2s _____
50 / .001	19.6 to 20.4s _____
5 / .01	18.0 to 22.4s _____
30 / .01	3.24 to 3.42s _____
50 / .01	1.96 to 2.04s _____
5 / .1	1.80 to 2.24s _____
30 / .1	324 to 342ms _____
50 / .1	196 to 204ms _____
5 / 1	180 to 224ms _____
30 / 1	32.4 to 34.2ms _____
50 / 1	19.6 to 20.4ms _____
5 / 10	18.0 to 22.4ms _____
30 / 10	3.24 to 3.42ms _____
50 / 10	1.96 to 20.4ms _____
5 / 100	1.80 to 2.24ms _____
30 / 100	2920 to 3080Hz _____
50 / 100	4900 to 5100Hz _____
5 / 1K	4450 to 5550Hz _____
30 / 1K	29.20kHz to 30.80kHz _____
50 / 1K	49.00kHz to 51.00kHz _____
5 / 10K	44.50kHz to 55.50kHz _____
30 / 10K	292.0kHz to 308.0kHz _____
50 / 10K	490.0kHz to 510.0kHz _____
5 / 100K	345.0kHz to 655.0kHz _____
30 / 100K	2.760MHz to 3.240MHz _____
50 / 100K	4.700MHz to 5.300MHz _____
Pulse and Ramp Dial Accuracy Check	
Dial / Range	Counter Indication
5 / 100K	400kHz to 600kHz _____
30 / 100K	2.65MHz to 3.35MHz _____
50 / 100K	4.45MHz to 5.55MHz _____
Sine Wave Distortion Check	
10Hz to 50kHz	> 46dB _____
50kHz to 500kHz	> 40dB _____
5MHz	> 30dB _____

PERFORMANCE CHECK TEST CARD (Cont'd)

Description	Check
Symmetry Check	
Below 20Hz	< 1% _____
20Hz to 50kHz	< 0.5% _____
Square Wave and Pulse Response Checks	
Full output rise time	< 30ns _____
Half output rise time	< 35ns _____
Aberration	< 5% _____
Sync rise time	< 20ns _____
Output Checks	
HIGH into 50 ohms	> 5.3Vrms _____
HIGH open circuit	> 10.6Vrms _____
OUTPUT LEVEL CCW	> 30dB below _____
LOW minimum output	< 30mV _____
Pulse = 2MHz	> 30Vp-p _____
Pulse = 5MHz	> 24Vp-p _____
SYNC output open circuit	> 4Vp-p _____
SYNC output into 50 ohms	> 2Vp-p _____
DC Offset	> +10Vp-p _____
	> -10Vp-p _____
Vacp +Vdc open circuit	> 15Vp _____
External Frequency Control Checks	
50kHz to 1kHz	-10V ±1.0V _____
1kHz to 50kHz	+10V ±1.0V _____

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

d. Manufacturer's part number.

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

DESIGNATORS

A	= assembly	F	= fuse	MP	= mechanical part	TC	= thermocouple
B	= motor	FL	= filter	P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
BT	= battery	HR	= heater	Q	= transistor		
C	= capacitor	IC	= integrated circuit	QCR	= transistor-diode	W	= cable
CR	= diode	J	= jack	R	= resistor	X	= socket
DL	= delay line	K	= relay	RT	= thermistor	XDS	= lampholder
DS	= lamp	L	= inductor	S	= switch	XF	= fuseholder
E	= misc electronic part	M	= meter	T	= transformer	Z	= network

ABBREVIATIONS

Ag	= silver	ID	= inside diameter	ns	= nanosecond (s) = 10^{-9} seconds	sl	= slide
Al	= aluminum	impg	= impregnated			SPDT	= single-pole double-throw
A	= ampere (s)	incd	= incandescent	nsr	= not separately replaceable		
Au	= gold	ins	= insulation (ed)			SPST	= single-pole single-throw
C	= capacitor	kΩ	= kilohm (s) = 10^{+3} ohms	Ω	= ohm (s)	Ta	= tantalum
cer	= ceramic	kHz	= kilohertz = 10^{+3} hertz	obd	= order by description	TC	= temperature coefficient
coef	= coefficient			OD	= outside diameter	TiO_2	= titanium dioxide
com	= common	L	= inductor	p	= peak		
comp	= composition	lin	= linear taper	pc	= printed circuit	tog	= toggle
conn	= connection	log	= logarithmic taper			tol	= tolerance
dep	= deposited	m	= milli = 10^{-3}	pF	= picofarad (s) = 10^{-12} farads	trim	= trimmer
DPDT	= double-pole double-throw					TSTR	= transistor
DPST	= double-pole single-throw	mA	= milliampere (s) = 10^{-3} amperes	piv	= peak inverse voltage	V	= volt (s)
				p/o	= part of	vacw	= alternating current working voltage
		MHz	= megahertz = 10^{+6} hertz	pos	= position (s)		
elect	= electrolytic	MΩ	= megohm (s) = 10^{+6} ohms	poly	= polystyrene	var	= variable
encap	= encapsulated	met flm	= metal film	pot	= potentiometer	vdcw	= direct current working voltage
		mfr	= manufacturer	p-p	= peak-to-peak		
F	= farad (s)	mtg	= mounting	ppm	= parts per million		
FET	= field effect transistor	mV	= millivolt (s) = 10^{-3} volts	prec	= precision (temperature coefficient, long term stability, and/or tolerance)	W	= watt (s)
fxd	= fixed	μ	= micro = 10^{-6}			w/	= with
GaAs	= gallium arsenide	μV	= microvolt (s) = 10^{-6} volts			wiv	= working inverse voltage
GHz	= gigahertz = 10^{+9} hertz	my	= Mylar ®			w/o	= without
						ww	= wirewound
gd	= guard (ed)	nA	= nanoampere (s) = 10^{-9} amperes	R	= resistor	*	= optimum value selected at factory, average value shown (part may be omitted)
Ge	= germanium	NC	= normally closed	Rh	= rhodium		
grd	= ground (ed)	Ne	= neon	rms	= root-mean-square		
		NO	= normally open	rot	= rotary		
H	= henry (ies)	NPO	= negative positive zero (zero temperature coefficient)	Se	= selenium	**	= no standard type number assigned (selected or special type)
Hg	= mercury			sect	= section (s)		
Hz	= hertz (cycle (s) per second)			Si	= silicon		

REV G

® Dupont de Nemours

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A1	**03310-66501**	**1**	**P.C. Board Ass'y: oscillator**	**-hp-**		
C1	0180-0116	2	C: fxd Ta elect 6.8uF 10% 35vdcw	-hp-		
C2,C3	0180-1719	2	C: fxd Ta elect 22uF 10% 25vdcw	56289	109D226X9025C2	
C4	0180-0116		C: fxd Ta elect 6.8uF 10% 35vdcw	-hp-		
C5	0180-0100	2	C: fxd Ta elect 4.7uF 10% 35vdcw	-hp-		
C6	0180-0161	2	C: fxd Ta elect 3.3uF 20% 35vdcw	-hp-		
C7	0180-0100		C: fxd Ta elect 4.7uF 10% 35vdcw	-hp-		
C8	0180-0161		C: fxd Ta elect 3.3uF 20% 35vdcw	-hp-		
C9	0150-0093	9	C: fxd cer 0.01uF +80% -20% 100vdcw	91418	TA	obd
C10	0140-0199	1	C: fxd mica 240pF 5%	-hp-		
C11	0160-3077	1	C: fxd my 0.027uF 10% 100vdcw	56289	225P2739WA1-PWM	
C12	0160-0938	4	C: fxd mica 1000pF 5%	-hp-		
C13	0160-0945	1	C: fxd mica 910pF 5%	-hp-		
C14	0160-3544	1	C: fxd polystyrene 0.01uF 5% 30vdcw	84411	HEW-196	obd
C15	0160-3399	1	C: fxd polycarbonate 0.1uF 5% 200vdcw	84411	HEW-131	obd
C16	0160-3402	1	C: fxd polycarbonate 1uF 5% 50vdcw	84411	HEW-138	obd
C17*	0140-0192	1	C: fxd mica 68pF 5%	-hp-		
C18,C19			Not assigned			
C20*	0150-0022	1	C: fxd TiO_2 3.3pF 10% 500vdcw	78488	Type GA	obd
C21	0160-0938		C: fxd mica 1000pF 5%	-hp-		
C22	0180-0291	2	C: fxd Ta elect 1.0uF 10% 35vdcw	-hp-		
C23	0160-0170	2	C: fxd cer .22uF +80% -20% 25vdcw	56289	5C9BS-CML	
C24			Not assigned			
C25	0160-0938		C: fxd mica 1000pF 5%	-hp-		
C26	0180-0291		C: fxd Ta elect 1.0uF 10% 35vdcw	-hp-		
C27	0160-0170		C: fxd cer .22uF +80% -20% 25vdcw	56289	5C9BS-CML	
C28 thru C31	0140-0202	5	C: fxd mica 15pF 5% 300vdcw	-hp-		
C32	0160-0763	1	C: fxd mica 5pF 10% 500vdcw	-hp-		
C33 thru C36	0150-0093		C: fxd 0.01uF	91418	TA	obd
C37,C38			Not assigned			
C39	0160-0938		C: fxd mica 1000pF 5%	-hp-		
C40	0140-0198	1	C: fxd mica 200pF 5% 300vdcw	-hp-		
C41	0160-3401	1	C: fxd polycarbonate 2uF 5% 50vdcw	84411	HEW-146	obd
CR1,CR2	1902-0049	2	Diode: breakdown 6.19V 5% 400mW	04713	SZ10939-122	
CR3,CR4	1901-0518	2	Diode: switching fast carrier	-hp-		
CR5 thru CR8			Not assigned			
CR9 thru CR12	1901-0025	19	Diode: Si 100 wiv 12pF 100mA	93332	D3072	obd
CR13 thru CR16	1901-0040	20	Diode: Si 30 wiv 2pF 30mA 2ns	07263	FDG1088	
CR17,CR18			Not assigned			
CR19,CR20	1901-0040		Diode: Si 30 wiv 2pF 30mA 2ns	07263	FDG1088	
CR21,CR22	1912-0016	2	Diode: Ge tunnel	01002	1N3713	
CR23 thru CR30	1901-0025		Diode: Si 100 wiv 12pF 100mA	93332	D3072	obd
IC1,IC2	1820-0203	3	Integrated Circuit: MA741C Amp	07263	SL8940	
J1 thru J6	1251-2194	6	Connector: single contact	00779	3-331272-0	
L1 thru L5			Not assigned			
L6	9140-0018	2	Inductor: fxd RF 1uH	000LQ	10100-31	
L7			Not assigned			
L8	9140-0018		Inductor: fxd RF 1uH	000LQ	10100-31	
Q1	1853-0086	2	TSTR: Si PNP**	-hp-		
Q2	1854-0215	16	TSTR: Si NPN 2N3904	04713	2N3904	
Q3	1854-0221	1	TSTR: Si NPN, Dual**	-hp-		
Q4	1854-0071	7	TSTR: Si NPN**	-hp-		
Q5	1853-0086		TSTR: Si PNP**	-hp-		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A1 (Cont'd)						
Q6	1854-0392	1	TSTR: Si NPN 2N5088	04713	2N5088	
Q7 thru Q11			Not assigned			
Q12	1855-0081	1	TSTR: FET N channel Type A 2N5245	01295	2N5245	
Q13	1854-0071		TSTR: Si NPN**	-hp-		
Q14	1854-0019	3	TSTR: Si NPN**	-hp-		
Q15	1854-0092	4	TSTR: Si NPN 2N3563	04713	2N3563	
Q16	1853-0034	4	TSTR: Si PNP 2N3634	04713	2N3634	
Q17,Q18	1854-0092		TSTR: Si NPN 2N3563	04713	2N3563	
Q19	1854-0019		TSTR: Si NPN**	-hp-		
Q20	1853-0034		TSTR: Si PNP 2N3634	04713	2N3634	
Q21	1854-0215	19	TSTR: Si NPN 2N3904	04713	2N3904	
Q22 thru Q25	1853-0036	16	TSTR: Si PNP 2N3906	04713	2N3906	
Q26 thru Q28	1854-0215		TSTR: Si NPN 2N3904	04713	2N3904	
Q29 thru Q30			Not assigned			
Q31	1854-0092		TSTR: Si NPN 2N3563	04713	2N3563	
Q32	1854-0019		TSTR: Si NPN**	-hp-		
Q33	1854-0092		TSTR: Si NPN 2N3563	04713	2N3563	
Q34	1854-0215		TSTR: Si NPN 2N3904	04713	2N3904	
Q35	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906	
Q36	1853-0203		TSTR: Si PNP	04713	SS5651	
Q37	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906	
Q38	1853-0034		TSTR: Si PNP 2N3634	04713	2N3634	
Q39	1854-0215		TSTR: Si NPN 2N3904	04713	2N3904	
Q40	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906	
Q41	1854-0215		TSTR: Si NPN 2N3904	04713	2N3904	
Q42	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906	
Q43			Not assigned			
Q44	1854-0087		TSTR: Si NPN**	-hp-		
Q45	1853-0012	2	TSTR: Si PNP 2N2904A	04713	2N2904A	
Q46	1854-0087		TSTR: Si NPN**	-hp-		
Q47	1854-0071		TSTR: Si NPN**	-hp-		
Q48	1854-0071		TSTR: Si NPN**	-hp-		
Q49,Q50	1853-0036		TSTR: 2N3906	04713	2N3906	
Q51	1855-0308	1	TSTR: FET N channel Type A Dual	-hp-		
R1 thru R6	2100-1738	8	R: var 10 kilohms 10% 1/2W Type H	73138	62PR10k	
R7	0698-6906	1	R: fxd flm 41.2 kilohms 0.5% 1/8W	75042	CEA T2	obd
R8	0683-1235	1	R: fxd comp 12 kilohms 5% 1/4W	01121	CB1235	
R9	0757-0458	1	R: fxd flm 51.1 kilohms 1% 1/8W	14674	C4S07	obd
R10,R11	0698-7311	4	R: fxd flm 85.6 kilohms 0.1% 1/8W 15PPM	000LQ	JC200	obd
R12	0698-3455	1	R: fxd flm 261 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R13 thru R15			Not assigned			
R16	0757-0453	1	R: fxd flm 30.1 kilohms 1% 1/8W	14674	C4S07	obd
R17	2100-1738		R: var 10 kilohms 10% 1/2W Type H	73138	62PR10k	
R18	0757-0279	1	R: fxd flm 3160 ohms 1% 1/8W	91637	CMF-1/10-32	obd
R19	0757-0407	2	R: fxd flm 200 ohms 1% 1/8W	14674	C4S07	obd
R20	0698-3245	1	R: fxd flm 20.5 kilohms 1% 1/8W	14674	C4S07	obd
R21	0683-1035	3	R: fxd 10 kilohms 5% 1/4W	01121	CB1035	
R22	0698-7312	2	R: fxd flm 15 kilohms .1% 1/8W 15PPM	000LQ	JC200	obd
R23	0757-0398	1	R: fxd flm 75 ohms 1% 1/8W	14674	C4S07	obd
R24	2100-2061	1	R: var 200 ohms 10% 1/2W Type H	73138	62PR200	
R25	0698-7312		R: fxd 15 kilohms .1% 1/8W 15PPM	000LQ	JC200	obd
R26	2100-1738		R: var 10 kilohms 10% 1/2W Type H	73138	62PR10k	
R27	0757-0472	1	R: fxd flm 200 kilohms 1% 1/8W	14674	C4S07	obd
R28	0698-4123	1	R: fxd flm 499 ohms 1% 1/8W	14674	C4S07	obd
R29	0698-3518	1	R: fxd flm 7320 ohms 1% 1/8W	14674	C4S07	obd
R30	0683-1035		R: fxd 10 kilohms 5% 1/4W	01121	CB1035	
R31	0698-6918	1	R: fxd flm 64.9 kilohms 0.5% 1/8W	75042	CEA T2	obd
R32,R33	0698-7311		R: fxd flm 85.6 kilohms 0.1% 1/8W 15OOM	000LQ	JC200	obd
R34	0698-6933	1	R: fxd flm 130 kilohms 0.5% 1/8W	91637	CMF-1/10-32	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A1 (Cont'd)						
R35	0698-3266	1	R: fxd flm 237 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R36	0698-4541	1	R: fxd flm 442 kilohms 1% 1/8W	91637	CMF-1/10-32	obd
R37	0757-0456	1	R: fxd flm 43.2 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R38	0683-3345	1	R: fxd comp 330 kilohms 5% 1/4W	01121	CB3345	
R39	0683-3335	2	R: fxd comp 33 kilohms 5% 1/4W	01121	CB3335	
R40	0698-0083	1	R: fxd flm 1960 ohms 1% 1/8W	14674	C4S07	obd
R41	0757-0280	6	R: fxd flm 1000 ohms 1% 1/8W	91637	CMF-1/10-32	obd
R42,R43	0683-1005	10	R: fxd comp 10 ohms 5% 1/4W	01121	CB1005	
R44	0683-3305	7	R: fxd comp 33 ohms 5% 1/4W	01121	CB3305	
R45 thru R49			Not assigned			
R50	0683-0475	1	R: fxd comp 4.7 ohms 5% 1/4W	01121	CB47G5	
R51,R52	0683-0275	2	R: fxd comp 2.7 ohms 5% 1/4W	01121	CB27G5	
R53	0683-3325	1	R: fxd comp 3300 ohms 5% 1/4W	01121	CB3325	
R54	0684-4721	1	R: fxd comp 4700 ohms 10% 1/4W	01121	CB4721	
R55	0684-2711	1	R: fxd comp 270 ohms 10% 1/4W	01121	CB2711	
R56	2100-2497	1	R: var 2000 ohms 10% 1/2W Type H	73138	62P	obd
R57	0757-0422	1	R: fxd flm 909 ohms 1% 1/8W	75042	CEA	obd
R58	0683-8205	1	R: fxd comp 82 ohms 5% 1/4W	01121	CB8205	
R59	0683-2015	4	R: fxd comp 200 ohms 5% 1/4W	01121	CB2015	
R60	0683-8215	2	R: fxd comp 820 ohms 5% 1/4W	01121	CB8215	
R61	0683-1625	1	R: fxd comp 1600 ohms 5% 1/4W	01121	CB1625	
R62 thru R64	0683-2015		R: fxd comp 200 ohms 5% 1/4W	01121	CB2015	
R65	0698-6860	1	R: fxd flm 98 ohms 0.25% 1/8W	91637	MF-1/10-32	obd
R66	0698-6697	1	R: fxd flm 402 ohms .25% 1/8W	91637	MF-1/10-32	obd
R67	0683-1015	3	R: fxd comp 100 ohms 5% 1/4W	01121	CB1015	
R68	0698-0058	1	R: fxd flm 4020 ohms 1% 1/4W	19701	MF52C	obd
R69,R70	0683-1005		R: fxd 10 ohms 5% 1/4W	01121	CB1005	
R71	0683-1045	4	R: fxd comp 100 kilohms 5% 1/4W	01121	CB1045	
R72	0698-4519	2	R: fxd flm 140 kilohms 1% 1/8W	14674	C4S07	obd
R73	0698-4493	2	R: fxd flm 34.0 kilohms 1% 1/8W	14674	C4S07	obd
R74	0757-0281	2	R: fxd flm 2740 ohms 1% 1/8W	14674	C4S07	obd
R75	0698-3151	2	R: fxd flm 2870 ohms 1% 1/8W	14674	C4S07	obd
R76	0757-0465	3	R: fxd flm 100 kilohms 1% 1/8W	14674	C4S07	obd
R77	0757-0739	2	R: fxd flm 2000 ohms 1% 1/4W	14674	MF-1/8-44	obd
R78	0683-1045		R: fxd comp 100 kilohms 5% 1/4W	01121	CB1045	
R79	0698-7322	2	R: fxd flm 4250 ohms 0.25% 1/8W	91637	CMF-1/10-32	obd
R80	0698-7319	2	R: fxd flm 4080 ohms 0.25% 1/8W	91637	CMF-1/10-32	obd
R81	0683-1045		R: fxd comp 100 kilohms 5% 1/4W	01121	CB1045	
R82	0698-4519		R: fxd flm 140 kilohms 1% 1/8W	14674	C4S07	obd
R83	0698-4493		R: fxd flm 34.0 kilohms 1% 1/8W	14674	C4S07	obd
R84	0757-0281		R: fxd flm 2740 ohms 1% 1/8W	14674	C4S07	obd
R85	0698-3151		R: fxd flm 2870 ohms 1% 1/8W	14674	C4S07	obd
R86	0757-0465		R: fxd flm 100 kilohms 1% 1/8W	14674	C4S07	obd
R87	0757-0739		R: fxd flm 2000 ohms 1% 1/4W	14674	MF-1/8-44	obd
R88	0683-1045		R: fxd comp 100 kilohms 5% 1/4W	01121	CB1045	
R89	0698-7322		R: fxd 4250 ohms 0.25% 1/8W	91637	CMF-1/10-32	obd
R90	0698-7319		R: fxd flm 4080 ohms .25% 1/8W	91637	CMF-1/10-32	obd
R91 thru R92			Not assigned			
R93, R94	0698-3240	2	R: fxd flm 500 ohms 0.25% 1/8W	91637	MF-1/10-32	obd
R95	0698-6624	2	R: fxd flm 2000 ohms 0.1% 1/8W	91637	CMF-1/10-32	obd
R96	0698-7393	2	R: fxd flm 301 ohms .25% 1/8W	91637	CMF-1/10-32	obd
R97,R98	0698-7394	2	R: fxd flm 698 ohms 0.1% 1/8W	91637	CMF-1/10-32	obd
R99	0698-7393		R: fxd flm 301 ohms 0.25% 1/8W	91637	CMF-1/10-32	obd
R100	0698-6624		R: fxd 2000 ohms .1% 1/8W	91637	CMF-1/10-32	obd
R101	0698-4458	2	R: fxd flm 590 ohms 1% 1/8W	14674	C4S07	obd
R102	0757-0290	3	R: fxd flm 6190 ohms 1% 1/8W	14674	C4S07	obd
R103	0757-0280		R: fxd flm 1000 ohms 1% 1/8W	91637	CMF-1/10-32	obd
R104	0757-0410		R: fxd flm 301 ohms 1% 1/8W	14674	C4S07	obd
R105	0698-4409	2	R: fxd flm 127 ohms 1% 1/8W	91637	MF-1/10-32	obd
R106	0757-0416	4	R: fxd flm 511 ohms 1% 1/8W	14674	C4S07	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A1 (Cont'd)						
R107	0757-0410	4	R: fxd flm 301 ohms 1% 1/8W	14674	C4S07	obd
R108	0698-4409		R: fxd flm 127 ohms 1% 1/8W	91637	MF-1/10-32	obd
R109	0757-0416		R: fxd flm 511 ohms 1% 1/8W	14674	C4S07	obd
R110	0757-0290		R: fxd flm 6190 ohms 1% 1/8W	14676	C4S07	obd
R111	0698-4458		R: fxd flm 590 ohms 1% 1/8W	14674	C4S07	obd
R112	0757-0280		R: fxd flm 1000 ohms 1% 1/8W	91637	CMF-1/10-32	obd
R113	0757-0178	5	R: fxd flm 100 ohms 1% 1/4W	14674	C5	obd
R114,R115	0683-1005		R: fxd 10 ohms 5% 1/4W	01121	CB-1005	
R116	0757-0178		R: fxd flm 100 ohms 1% 1/4W	14674	C5	obd
R117 thru R118			Not assigned			
R119,R120	0757-0416		R: fxd flm 511 ohms 1% 1/8W	14674	C4S07	obd
R121	0757-0178		R: fxd flm 100 ohms 1% 1/4W	14674	C5	obd
R122,R123	0683-1005		R: fxd 10 ohms 5% 1/4W	01121	CB1005	
R124	0757-0178		R: fxd flm 100 ohms 1% 1/4W	14674	C5	obd
R125	0683-8215		R: fxd comp 820 ohms 5% 1/4W	01121	CB8215	
R126	0683-1025	5	R: fxd comp 1000 ohms 5% 1/4W	01121	CB1025	
R127	0683-3915	1	R: fxd comp 390 ohms 5% 1/4W	01121	CB3915	
R128,R129	0683-1005		R: fxd 10 ohms 5% 1/4W	01121	CB1005	
R130 thru R131			Not assigned			
R132	0698-7487	1	R: fxd 1640 ohms 0.5% 1/4W	14674	NC5	obd
R133,R134	0683-4705	2	R: fxd comp 47 ohms 5% 1/4W	01121	CB4705	
R135	0683-1535	1	R: fxd comp 15 kilohms 5% 1/4W	01121	CB1535	
R136	0683-3315	2	R: fxd comp 330 ohms 5% 1/4W	01121	CB3315	
R137	0683-5125	3	R: fxd comp 5100 ohms 5% 1/4W	01121	CB5125	
R138	0683-1835	1	R: fxd comp 18 kilohms 5% 1/4W	01121	CB1835	
R139	0683-2025	2	R: fxd comp 2000 ohms 5% 1/4W	01121	CB2025	
R140	0698-3228	1	R: fxd flm 49.9 kilohms 1% 1/8W	14674	C4S07	obd
R141,R142			Not assigned			
R143	0698-7316	1	R: fxd flm 20 megohms 0.5% 1/2W	00327	M12	obd
R144	0698-7317	1	R: fxd flm 2.0 megohms 0.5% 1/2W	00327	M12D	obd
R145	0698-6090	1	R: fxd 199.8 kilohms .1% 1/8W	91637	MF-1/10-32	obd
R146	0698-7313	1	R: fxd flm 19.8 kilohms .1% 1/8W	91637	CMF-1/10-32	obd
R147	0698-7486	1	R: fxd 1780 ohms 0.25% 1/8W	91637	MF-1/10-32	obd
R148	0757-0462	2	R: fxd flm 75 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R149	0683-1025		R: fxd comp 1000 ohms 5% 1/4W	01121	CB1025	
R150	0757-0123	1	R: fxd flm 34.8 kilohms 1% 1/8W	14674	C4S07	obd
R151	0683-1025		R: fxd comp 1000 ohms 5% 1/4W	01121	CB1025	
R152	0757-0462		R: fxd flm 75 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R153	0683-1035		R: fxd 10 kilohms 5% 1/4W	01121	CB1035	
R154	0757-0410		R: fxd flm 301 ohms 1% 1/8W	14674	C4S07	obd
R155	**0757-0410**		**Not assigned**	**14674**	**C4S07**	**obd**
R156	**0683-6225**		**R: fxd flm 301 ohms 1% 1/8W**	**01121**	**CB6225**	
R157			**R: fxd comp 6200 ohms 5% 1/4W**			
R158 thru R161			**Not assigned**	**73138**	**62PR100**	
R162	**2100-1984**		**R: var 100 ohms 10% 1/2W Type H**	**01121**	**CB27G1**	
R163 thru R168	**1205-0271**	6	**R: fxd comp 2.7 ohms 10% 1/4W**	**98978**	**TXBF-019-025B**	
	1205-0037	4	Heat dissipator-T018	98978	TXBF-019-025B	
S2	03310-61901	1	Switch assembly: range Includes A1R43 thru A1R47	-hp-		
	3100-2701	1	Switch: rotary	-hp-		
A2	**03310-66502**	**1**	**P.C. Board Ass'y: control**	**-hp-**		
C1*	0150-0046	1	C: fxd TiO_2 0.68pF 5% 500 vdcw	78488	Type GA	obd
C2*	0160-2201	1	C: fxd mica 51pF 5% 300 vdcw	-hp-		
C3	0121-0430	1	C: var 1.4-9.2pF	74970	189-503-105	
C4	0150-0042	1	C: fxd TiO_2 4.7pF 5% 500 vdcw	78488	Type GA	obd
C5	0140-0202	2	C: fxd mica 15pF 5%	-hp-		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A2 (Cont'd)						
C6*	0150-0045	1	C: fxd TiO_2 8.2pF 5% 500 vdcw	78488	Type GA	obd
C7,C8	0180-0058	2	C: fxd Al elect 50uF +75% -10% 25 vdcw	56289	30D506G025CC2-DSM	
C9,C10	0180-0197	2	C: fxd Ta elect 2.2uF 10% 20 vdcw	-hp-		
L1	9140-0179	1	Inductor: fxd 22uH 10%	000LQ	15-4445-7J	
Q1,Q2	5080-4668	2	TSTR: aged	-hp-		
Q3	1854-0034		TSTR: Si PNP 2N3634	04713	2N3634	
Q4	1854-0053	1	TSTR: Si PNP 2N2218	04713	2N2218	
R1	0698-7315	1	R: fxd flm 4250 ohms 0.1% 1/4W	91637	CMF-1/8-44	obd
R2	0698-7326	1	R: fxd flm 2167 ohms 0.1% 1/2W	91637	MFF-1/1-15	obd
R3	0698-7318	1	R: fxd flm 14.45 kilohms 0.25% 1/8W	91637	CMF-1/10-32	obd
R4	0698-7314	1	R: fxd flm 8500 ohms 0.1% 1/4W	91637	CMF-1/8-44	obd
R5	0698-7325	1	R: fxd met flm 2535 ohms 0.25% 1/2W	91637	MFF-1/2-15	obd
R6	2100-2520	1	R: var cermet flm 50 ohms 20% 1/2W Type V	73138	62-91-0	obd
R7			Not assigned			
R8	0683-5105	3	R: fxd comp 51 ohms 5% 1/4W	01121	CB5105	
R9*	0698-3178	1	R: fxd flm 487 ohms 1% 1/8W	14674	C4S07	
R10	0757-0407		R: fxd flm 200 ohms 1% 1/8W	14674	C4S07	obd
R11	0757-0283	1	R: fxd flm 2000 ohms 1% 1/8W	14674	C4S07	obd
R12	0698-4426	2	R: fxd flm 1580 ohms 1% 1/8W	14674	C4S07	obd
R13	0698-3226	1	R: fxd flm 6490 ohms 1% 1/8W	14674	C4	obd
R14	0757-0280		R: fxd flm 1000 ohms 1% 1/8W	91637	CMF-1/10-32	obd
R15	0698-3153	1	R: fxd flm 3830 ohms 1% 1/8W	14674	C4S07	obd
R16	0757-0280		R: fxd flm 1000 ohms 1% 1/8W	91637	CMF-1/10-32	obd
R17	0698-3207	1	R: fxd flm 499 ohms 1% 1/4W	91637	MF-1/8-44	obd
R18*	0757-0278	1	R: fxd flm 1780 ohms 1% 1/8W	14674	C4S07	obd
R19			Not assigned			
R20	2100-0024	1	R: var comp 1000 ohms 10% 2-1/2W taper	01121	Type j	obd
R21	0683-0465	1	R: fxd comp 27 ohms 5% 1/4W	01121	CB2705	
R22	0757-0465	1	R: fxd flm 100 kilohms 1% 1/8W	14674	C4S07	obd
R23	2100-2514	1	R: var cermet flm 20 kilohms 1/2W	73138	62-228-1	
S3	3100-2702	1	Switch: rotary	-hp-		
	03310-00602	1	Bracket: switch and level	-hp-		
	1251-1633	1	Connector P.C.: 15 pin	71785	252-15-30-310	
	1251-1634	1	Connector P.C.: 18 pin	07233	66-710-18	
A3	**03310-66503**	**1**	**P.C. Board Ass'y: amplifier**	**-hp-**		
C1,C2	0150-0121	2	C: fxd cer 0.1uF +80% -20% 50 vdcw	56289	5C50B1S-CML	
C3,C4			Not assigned			
C5,C6	0180-2050	2	C: fxd Ta elect .082uF 10% 35 vdcw	90201	TAS823K035P1A	
C7 thru C9	0150-0093		C: fxd cer 0.01uF +80% -20% 100 vdcw	91418	TA	obd
C10	0150-0069	2	C: fxd cer 0.001uF 500 vdcw	72982	801-010X5G0102Z	
C11	0180-0376		C: fxd Ta elect 0.47uF 10% 35 vdcw	90201	TAS474K035P1A	
C12	0150-0069		C: fxd cer 0.001uF 500 vdcw	72982	801-010X5G0102Z	
C13	0180-0376		C: fxd Ta elect 0.47uF 10% 35 vdcw	90201	TAS474K035P1A	
C14			Not assigned			
C15	0150-0093		C: fxd cer 0.01uF +80% -20% 100 vdcw	91418	TA	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A3 (Cont'd)						
C16,C17			Not assigned			
C18,C19	0180-0291	4	C: fxd Ta elect 1uF 10% 35 vdcw	56289	150D105X9035A2-DYS	
C20	0180-0049	2	C: fxd Al elect 20uF +75% -20% 50 vdcw	56289	30D206G050CC2-DSM	
C21	0160-2197	2	C: fxd mica 10pF 5%	-hp-		
C22	0180-0049		C: fxd Al elect 20uF +75% -20% 50 vdcw	56389	30D206G050CC2-DSM	
C23	0160-2197		C: fxd mica 10pF	-hp-		
C24	0160-0159	1	C: fxd my 6800pF 10% 200vdcw	-hp-		
C25	0160-0301	1	C: fxd my 0.012uF 10% 200 vdcw	-hp-		
CR1 thru CR14	1901-0040		Diode: Si 30 wiv 2pF 30mA 2ns	07263	FDG1088	
CR15 thru CR20	1901-0025		Diode: Si 100 wiv 12pF 100mA	93332	D3072	obd
CR21	1901-0527	2	Diode: current regulator	-hp-		
CR22			Not assigned			
CR23	1901-0527		Diode: current regulator	-hp-		
CR24			**Not assigned**			
CR25	**1901-0025**		**Diode: Si 100 wiv 12pF 100mA**	**93332**	**D3072**	**obd**
CR26	**1902-0786**	**1**	**Diode: zener 9V 5% 500mW**	**04713**	**1N937**	
CR27			**Not assigned**			
CR28	**1902-0681**	**1**	**Diode: breakdown 9.09V 10% 400mW**	**04713**		**obd**
IC1	**1820-0203**		**Integrated Circuit: MA741C AMP**	**07263**	**SL8940**	
Q1	1854-0071		TSTR: Si NPN**	-hp-		
Q2	1853-0020	3	TSTR: Si PNP**	-hp-		
Q3	1854-0071		TSTR: Si NPN**	-hp-		
Q4	1853-0020		TSTR: Si PNP**	-hp-		
Q5	1854-0071		TSTR: Si NPN**	-hp-		
Q6	**1853-0020**		**TSTR: Si PNP****	**-hp-**		
Q7,Q8			**Not assigned**			
Q9	**1853-0015**	**1**	**TSTR: Si PNP 2N3640**	**04713**	2N3640	
Q10	**1853-0007**	**1**	**TSTR: PNP JEDEC type 2N3251**	**04713**	2N3251	
Q11	**1854-0351**	**1**	**TSTR: Si NPN****	**-hp-**		
Q12	**1854-0009**	**2**	**TSTR: Si NPN 2N709**	04713	**SS7376K**	
Q13	**1854-0215**		**TSTR: Si NPN 2N3904**	04713	**2N3904**	
Q14	**1853-0042**	**1**	**TSTR: Si PNP****	-hp-		
Q15,Q16			**Not assigned**			
Q17	1854-0402	2	**TSTR: Si NPN TIP-29**	01295	TIP-29	
Q18,Q19	1854-0215		TSTR: Si NPN 2N3904	04713	2N3904	
Q20	1854-0087	3	TSTR: Si NPN**	-hp-		
Q21	1853-0233	2	TSTR: Si TIP-32 PNP	01295	TIP-32	
Q22 thru Q24	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906	
Q25	1853-0233		TSTR: TIP-32 PNP	01295	TIP-32	
Q26 thru Q28	1853-0036		TSTR: 2N3906	04713	2N3906	
Q29	1854-0221	1	TSTR: Si NPN dual**	-hp-		
Q30	1854-0402		TSTR: Si NPN TIP-29	01295	TIP-29	
Q31 thru Q35	1854-0215		TSTR: Si NPN 2N3904	04713	2N3904	
R1			Not assigned			
R2	0698-4470	2	R: fxd flm 6980 ohms 1% 1/8W	91637	MF-1/10-32	obd
R3	0698-3492	2	R: fxd flm 2670 ohms 1% 1/8W	14674	C4S07	obd
R4	2100-1788	3	R: var 500 ohms 10% 1/2W Type H	73138	62PR500	
R5	0683-5125		R: fxd comp 5100 ohms 5% 1/4W	01121	CB5125	
R6	0683-1825	2	R: fxd comp 1800 ohms 5% 1/4W	01121	CB1825	
R7	0683-5115	6	R: fxd comp 510 ohms 5% 1/4W	01121	CB5115	
R8	0683-3905	2	R: fxd comp 39 ohms 5% 1/4W	01121	CB3905	
R9	0683-1215	1	R: fxd comp 120 ohms 5% 1/4W	01121	CB1215	
R10	0683-3905		R: fxd comp 39 ohms 5% 1/4W	01121	CB3905	
R11	0683-3005	2	R: fxd comp 30 ohms 5% 1/4W	01121	CB3005	
R12	0683-3315		R: fxd comp 330 ohms 5% 1/4W	01121	CB3315	
R13	0683-3005		R: fxd comp 30 ohms 5% 1/4W	01121	CB3005	
R14	0683-4705	2	R: fxd comp 47 ohms 5% 1/4W	01121	CB4705	
R15	0683-4715	1	R: fxd comp 470 ohms 5% 1/4W	01121	CB4715	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A3 (Cont'd)						
R16	0683-4705		R: fxd comp 47 ohms 5% 1/4W	01121	CB4705	
R17	0683-8205	2	R: fxd comp 82 ohms 5% 1/4W	01121	CB8205	
R18	0683-1025		R: fxd comp 1000 ohms 5% 1/4W	01121	CB1025	
R19	0683-8205		R: fxd comp 82 ohms 5% 1/4W	01121	CB8205	
R20	0683-3305		R: fxd comp 33 ohms 5% 1/4W	01121	CB3305	
R21	0683-2025		R: fxd comp 2000 ohms 5% 1/4W	01121	CB2025	
R22	0683-3305		R: fxd comp 33 ohms 5% 1/4W	01121	CB3305	
R23,R24	0683-1015		R: fxd 100 ohms 5% 1/4W	01121	CB1015	
R25	0698-4470		R: fxd flm 6980 ohms 1% 1/8W	91637	MF-1/10-32	obd
R26	0698-3492		R: fxd flm 2670 ohms 1% 1/8W	14674	C4S07	obd
R27	2100-1788		R: var 500 ohms 10% 1/2W Type H	73138	62PR500	
R28	0683-5125		R: fxd comp 5100 ohms 5% 1/4W	01121	CB5125	
R29	0683-1825		R: fxd comp 1800 ohms 5% 1/4W	01121	CB1825	
R30	0683-5115		R: fxd comp 510 ohms 5% 1/4W	01121	CB5115	
R31	0757-0280		R: fxd flm 1000 ohms 1% 1/8W	91637	CMF-1/10-32	obd
R32	**0698-3515**	**1**	**R: fxd flm 5900 ohms 1% 1/8W**	**75042**	**CEA**	obd
R33	**0683-1025**		**R: fxd comp 1000 ohms 5% 1/4W**	**01121**	**CB1025**	
R34,R35		**1**	**Not assigned**			
R36	**0757-0427**	**1**	**R: fxd flm 1500 ohms 1% 1/8W**	**91637**	**CMF-1/10-32**	**obd**
R37 thru R39			**Not assigned**			
R40	0683-9105	2	R: fxd comp 91 ohms 5% 1/4W	01121	CB9105	
R41	0698-4469	2	R: fxd flm 1150 ohms 1% 1/8W	14674	C4S07	obd
R42	0698-4307	1	R: fxd flm 14.3 kilohms 1% 1/8W	14674	C4S07	obd
R43	0698-4421	1	R: fxd flm 249 ohms 1% 1/8W	14674	C4	obd
R44	0683-5105		R: fxd comp 51 ohms 5% 1/4W	01121	CB5105	
R45	0698-0063	2	R: fxd flm 5230 ohms 1% 1/8W	91637	MF-1/10-32	obd
R46	0698-3499	1	R: fxd flm 40.2 kilohms 1% 1/8W	14674	CMF-1/10-32	obd
R47	0683-2005	2	R: fxd comp 20 ohms 5% 1/4W	01121	CB2005	
R48	0698-0063		R: fxd flm 5230 ohms 1% 1/8W	91637	MF-1/10-32	obd
R49	0683-2005		R: fxd comp 20 ohms 5% 1/4W	01121	CB2005	
R50	0683-9105		R: fxd comp 91 ohms 5% 1/4W	01121	CB9105	
R51	0698-4469		R: fxd flm 1150 ohms 1% 1/8W	14674	C4S07	obd
R52	0683-5105		R: fxd comp 51 ohms 5% 1/4W	01121	CB5105	
R53	0757-0415	1	R: fxd flm 475 ohms 1% 1/8W	14674	C4S07	obd
R54 thru R59			Not assigned			
R60,R61	0683-3305		R: fxd comp 33 ohms 5% 1/4W	01121	CB3305	
R62	0698-3609	2	R: fxd met oxide 22 ohms 5% 2W	14674	C42S	obd
R63,R64	0698-4059	2	R: fxd carbon comp 5.6 ohms 10% 1/2W	01121	EB56G1	
R65	0698-3609		R: fxd met oxide 22 ohms 5% 2W	14674	C42S	obd
R66	0698-3615	1	R: fxd met oxide 47 ohms 5% 2W	14674	C42S	obd
R67,R68	0683-3305		R: fxd comp 33 ohms 5% 1/4W	01121	CB3305	
R69*	0757-0290		R: fxd flm 6190 ohms 1% 1/8W	14674	C4S07	obd
R70			Not assigned			
R71	0686-0275	2	R: fxd comp 2.7 ohms 5% 1/2W	01121	EB0275	
R72	0683-3315	2	R: fxd comp 330 ohms 5% 1/4W	01121	CB3315	
R73	0683-2435	4	R: fxd comp 24 kilohms 5% 1/4W	01121	CB2435	
R74	0698-4485	2	R: fxd flm 23.2 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R75	0757-0442	2	R: fxd flm 10 kilohms 1% 1/8W	91637	CMF-1/10-32	obd
R76	0686-0275		R: fxd comp 2.7 ohms 5% 1/2W	01121	EB0275	
R77	0683-3315		R: fxd comp 330 ohms 5% 1/4W	01121	CB3315	
R78	0683-2435		R: fxd comp 24 kilohms 5% 1/4W	01121	CB2435	
R79	0698-4485		R: fxd flm 23.2 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R80	0757-0442		R: fxd flm 10 kilohms 1% 1/8W	91637	CMF-1/10-32	obd
R81,R82	0683-0335	4	R: fxd comp 3.3 ohms 5% 1/4W	01121	CB0335	
R83	0683-5115		R: fxd comp 510 ohms 5% 1/4W	01121	CB5115	
R84	0683-2435		R: fxd comp 24 kilohms 5% 1/4W	01121	CB2435	
R85	0683-4735	2	R: fxd comp 47 kilohms 5% 1/4W	01121	CB4735	
R86	0683-1225	2	R: fxd comp 1200 ohms 5% 1/4W	01121	CB1225	
R87			Not assigned			
R88	0698-4502	1	R: fxd flm 64.9 kilohms 1% 1/8W	14674	C4S07	obd

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A3 (Cont'd)						
R89	0698-4497	1	R: fxd flm 48.7 kilohms 1% 1/8W	91637	CMF-1/10-32	obd
R90,R91	0698-6348	2	R: fxd flm 3000 ohms 0.1% 1/8W	91637	CMF-1/10-32	obd
R92,R93	0683-0335		R: fxd 3.3 ohms 5% 1/4W	01121	CB0335	
R94	0683-5115		R: fxd comp 510 ohms 5% 1/4W	01121	CB5115	
R95	0683-2435		R: fxd comp 24 kilohms 5% 1/4W	01121	CB2435	
R96	0683-4735		R: fxd comp 47 kilohms 5% 1/4W	01121	CB4735	
R97	0683-1225		R: fxd comp 1200 ohms 5% 1/4W	01121	CB1225	
R98	0698-0084	1	R: fxd flm 2150 ohms 1% 1/8W	19701	MF4C	obd
R99	0698-4489	1	R: fxd flm 28.0 kilohms 1% 1/8W	14674	C4S07	obd
R100	0757-0454	1	R: fxd flm 33.2 kilohms 1% 1/8W	91637	MF-1/10-32	obd
R101	2100-1788		R: var 500 ohms 10% 1/2W Type H	73138	62PR500	
R102	0698-4420	1	R: fxd flm 226 ohms 1% 1/8W	91637	MFF-1/8-T-1	obd
R103	0698-3153	1	R: fxd flm 3830 ohms 1% 1/8W	14674	C4S07	obd
	1205-0037	4	Heat dissipator for semiconductor T018	98978	TXBF-019-025B	
	0340-0473	4	Insulator: transistor	13103	10176	
A4	**03310-66504**	**1**	**P.C. Board Ass'y: pri**	**-hp-**		
C1,C2	0180-1956	2	C: fxd 500uF 50 vdcw	56289	39D507G050GL4-DSB	
C3,C4	0180-1985	2	C: fxd 500uF +70% -10% 30 vdcw	56289	39D507G030FL4-DSB	
CR1 thru CR8	1901-0158	8	Diode: Si 200 piv 0.75A	04713	SR1358-3	
	1251-1941	1	Connector P.C.: 6 pin	71785	252-06-30-310	
			CHASSIS MOUNTED COMPONENTS			
C1,C2	0180-0291		C: fxd Ta elect 1uF 10% 35 vdcw	56289	150D105X9035A2-DYS	
DS1	2140-0015	1	Lamp: neon	24455	NE-2H	
F1	2110-0044	1	Fuse: .30A s-b	71400	MDL 3/10	
F1	2110-0320	1	Fuse: .15A s-b (230V operation only)	71400	MDL 15/100	
J1,J2	1250-0083	3	Connector: BNC	000LB	28JR-130-1	
J3	1250-0118	1	Connector: BNC	000LB	28JR128-1	
J4	1250-0083		Connector: BNC	000LB	28JR-130-1	
J5	1251-2357	1	Connector: AC power	82389	EAC-301	
Q1	1854-0254	1	TSTR: Si NPN	04713	SS2065	
Q2	1853-0012		TSTR: Si PNP 2N2904A	04713	2N2904A	

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.	
			CHASSIS MOUNTED COMPONENTS (Cont'd)			
R1	2100-2833	1	R: var lin taper 1 kilohm 10% 3/4W	73138	Type 3351	obd
R2,R3			Not assigned			
R4	0683-3335		R: fxd comp 33 kilohms 5% 1/4W	01121	CB3335	
R5	0698-4426		R: fxd flm 1580 ohms 1% 1/8W	14674	C4S07	obd
R6	0757-0394	1	R: fxd flm 51.1 ohms 1% 1/8W	14674	C4S07	obd
S1	3101-0036	1	Switch: SPST	88140	8928K61	
S4	03310-61902	1	Switch ass'y: D.C. offset Consists of S4 and R2	-hp-		
S4	3100-2703	1	Switch: rotary	-hp-		
R2	2100-2840	1	R: var 1 kilohm	71482	Type 551	obd
S5	**3101-1234**	1	**Switch: DPST non-shorting**	82389	**11A-1242**	
T1	9100-1459	1	Transformer: power	-hp-		
W1	**8120-1348**	1	**Cord: power black 7.5 ft. long**	70903	**KH-7041**	
			MISCELLANEOUS			
	0370-0030	1	Knob: dial frequency	-hp-		
	0370-0077	2	Knob: 5/8 in. bar, function and range	-hp-		
	0370-0099	1	Knob: 5/8 in. bar, DC offset	-hp-		
	0370-0133	1	Knob: 5/8 in., output level	-hp-		
	0370-0178	1	Knob: 1/2 in. vernier	-hp-		
	0370-0843	1	Knob: 1/2 in. gray	-hp-		
	1400-0084	1	Holder: fuse	75915	342-014	
	1490-0032	1	Stand: tilt	-hp-		
	1500-0231	1	Vernier drive	-hp-		
	03310-09101	1	Spring: vernier	-hp-		
	1410-0942	1	Bushing: threaded vernier drive	-hp-		
	5000-0150	2	Cover: side	-hp-		
	5000-0716	1	Cover: bottom	-hp-		
	5000-5838	2	Cover: bracket	-hp-		
	0590-0052	6	Nuts: sheet metal clip	-hp-		
	5060-0728	2	Foot ass'y: HM	-hp-		
	5060-5922	1	Cover ass'y: top	-hp-		
	7120-1254	1	Plate: identification LOGO	-hp-		
	03310-00201	1	Panel: front	hp-		
	03310-00202	1	Panel: rear	-hp-		
	03310-64001	1	Dial ass'y: frequency	-hp-		
	03310-00606	1	Bracket: terminal, Q1 and Q2	-hp-		
	1205-0205	4	Heat sinks: Q1 and Q2	-hp-		
	03310-21101	4	Heat sink: A3 ass'y	-hp-		
	1410-0943	1	Bushing: threaded range switch	96881	4L4-F	
	03310-00604	1	Bracket: A1 ass'y support	-hp-		
	5020-0233	1	Collar: frequency dial stop	-hp-		
	5040-0234	1	Pilot lens: clear	-hp-		
	5040-0235	1	Base: lampholder	-hp-		
	5060-0238	2	Frame ass'y: 4 1/2 X 8 SM	-hp-		
	03310-90000	1	Manual: operating and service	-hp-		

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section contains the Functional Block Diagram and the Detailed Schematic Diagrams for the Model 3310A.

7-3. FUNCTIONAL BLOCK DIAGRAM.

7-4. The Functional Block Diagram is a block diagram of the entire instrument, which also shows variable components used in the Adjustment and Calibration Procedure and important test points.

7-5. SCHEMATIC DIAGRAMS.

7-6. Figures 7-2 through 7-5 are detailed schematic diagrams of the circuits in the 3310A. The dc voltage levels or waveforms shown on the diagrams are subject to any conditions stated in the NOTES on that diagram.

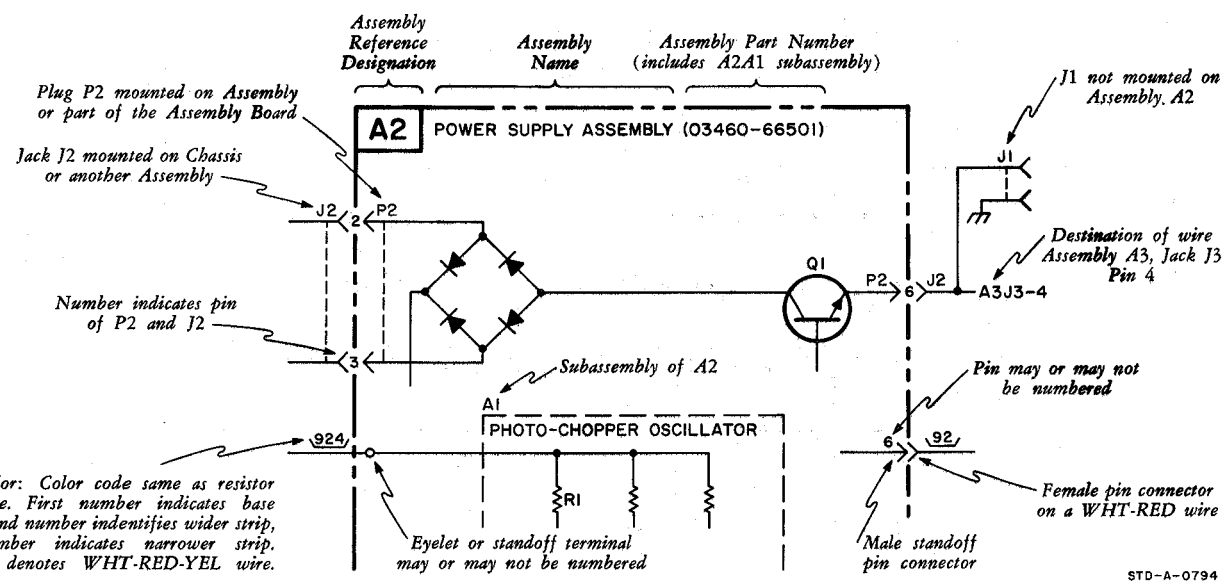
7-7. COMPONENT LOCATION DIAGRAMS.

7 8. Included with each schematic diagram is a component location diagram to assist in the location of components on the assembly. Each component is identified by the reference designator used on the schematic diagram and in the replaceable parts list.

REFERENCE DESIGNATIONS

PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

ASSEMBLY	SUBASSEMBLY	COMPONENT	COMPLETE DESIGNATION
A2	NONE	Q1	A2Q1
A2	A1	R1	A2A1R1
NONE	NONE	J1	J1


Assembly Reference Designation
Assembly Name
Assembly Part Number (includes A2A1 subassembly)
Plug P2 mounted on Assembly or part of the Assembly Board
Jack J2 mounted on Chassis or another Assembly
A2
POWER SUPPLY ASSEMBLY (03460-66501)
J1 not mounted on Assembly A2
J1
J2
P2
2
Q1
P2
6
J2
A3J3-4
Destination of wire Assembly A3, Jack J3 Pin 4
Number indicates pin of P2 and J2
3
Subassembly of A2
A1
PHOTO-CHOPPER OSCILLATOR
Pin may or may not be numbered
924
R1
6
92
Wire Color: Color code same as resistor color code. First number indicates base color, second number indentifies wider strip, third number indicates narrower strip. E.g. 924, denotes WHT-RED-YEL wire.
Eyelet or standoff terminal may or may not be numbered
Female pin connector on a WHT-RED wire
Male standoff pin connector
STD-A-0794

SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. USE ASSEMBLY PREFIX DESIGNATION WITH REFERENCE DESIGNATION FOR COMPLETE REFERENCE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:

   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS

3. ⏚ DENOTES POWER LINE GROUND.
4. ⏚ DENOTES COMMON CIRCUIT GROUND.
5. ▽ DENOTES CIRCUIT GROUND WHICH IS ISOLATED WHEN ASSEMBLY IS REMOVED FROM INSTRUMENT.
6. DENOTES ASSEMBLY.
7. DENOTES MAIN SIGNAL PATH.
8. DENOTES FEEDBACK PATH.
9. DENOTES FRONT PANEL MARKING.
10. DENOTES REAR PANEL MARKING.
11. DENOTES FRONT PANEL CONTROL.
12. DENOTES SCREWDRIVER ADJUST.
13. DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.
14. * OPTIMUM VALUE SELECTED AT FACTORY. COMPONENT MAY BE MISSING.
15. DC VOLTAGES SHOWN AROUND TRANSISTORS ARE DEPENDENT ON CONDITIONS SET FORTH IN SCHEMATIC NOTES.

A1

+10V
FREQUENCY DIAL

RANGE
① ⑤ R1
⑥ R2
⑦ R3
⑧ R4
⑨ R5
⑩ R6

R7
R9
VCO INPUT

TP1
TP10

R22
R24
+10V
R26
-10V
INVERTING AMPLIFIER IC2 & Q2
TP3

P/O A2
FUNCTION
SQ
SINE
TRI
R1
R2

R10
R11
+10V
R17
-10V
TUNING AMPLIFIER IC1 & Q1
TP2

RANGE
① .0001
② .001
③ .01
④ .1
⑤ 1
⑥ 10
⑦ 100
⑧ 1K
⑨ 10K
⑩ 100K

BIAS NETWORK Q3-Q4
Q5
CR4
CR3
Q6

P/O A2
FUNCTION
SQ
SINE
TRI
R4
R3
R6

RANGE
S2
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩
C16 1.0
C15 0.1
R51 2.7
C14 .01
R50 4.7
C13 910PF

C17 68PF

TRIANGLE AMPLIFIER Q12-Q20
TP4
R56
-10V
R66
R65

HIGH FREQUENCY LEVEL DETECTOR Q21-Q28
①
⑨

RANGE
① ② ③ ④ ⑤-⑩

RANGE
①-⑤
⑥-⑩
R132
LOW FREQUENCY FEEDBACK AMPLIFIER Q44-Q51
R162

COPYRIGHT 1969 BY HEWLETT-PACKARD COMPANY

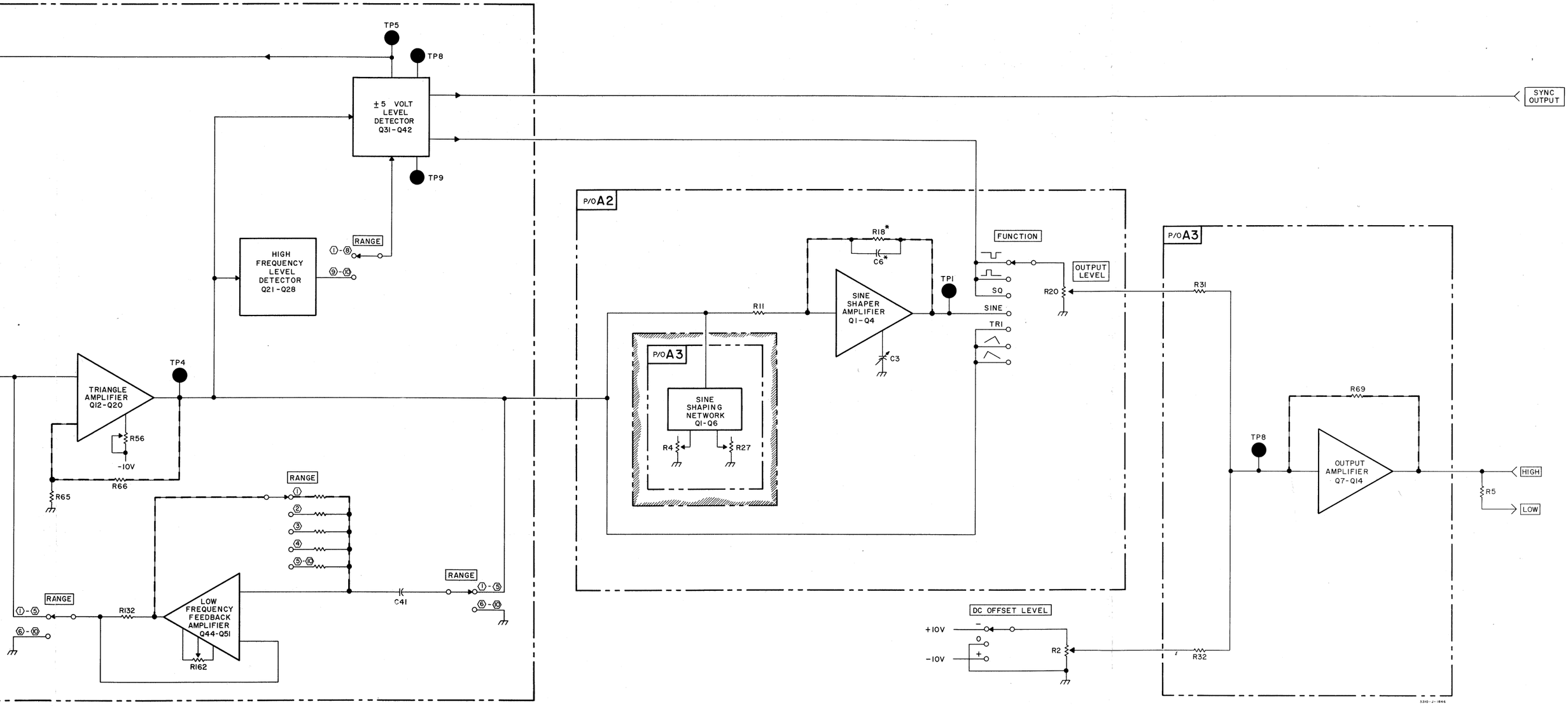
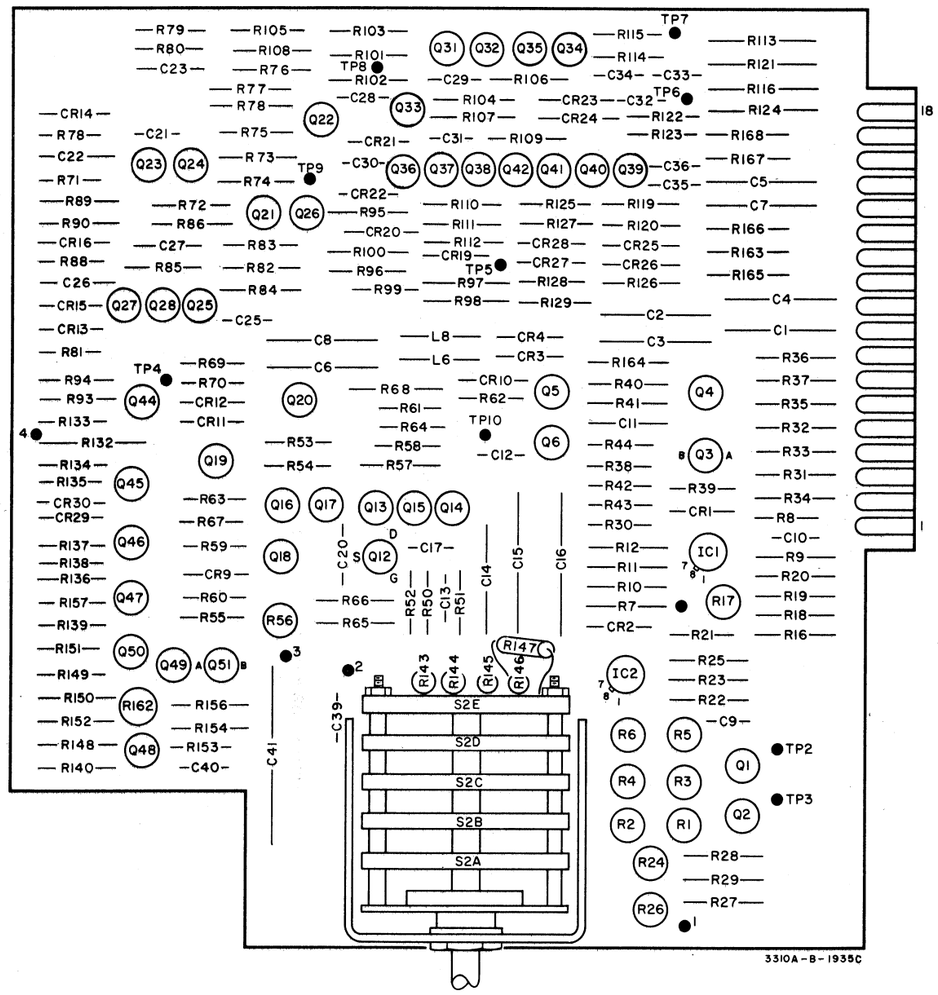
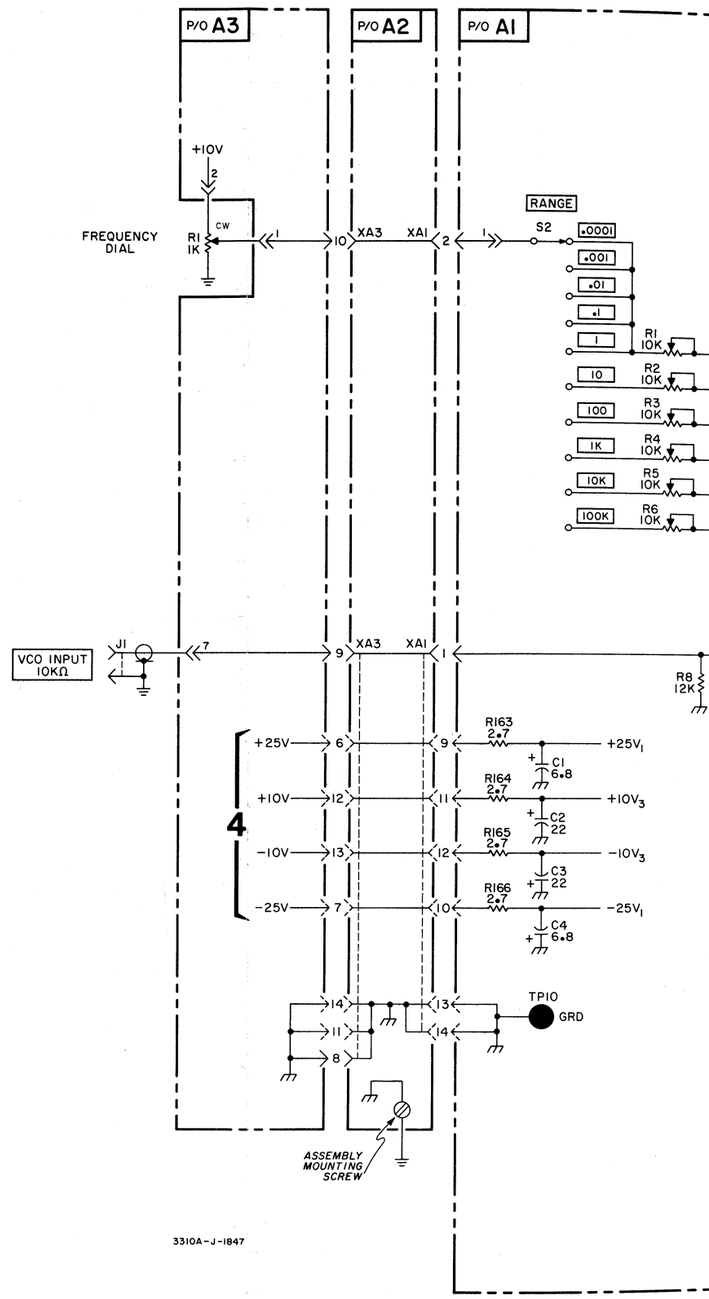


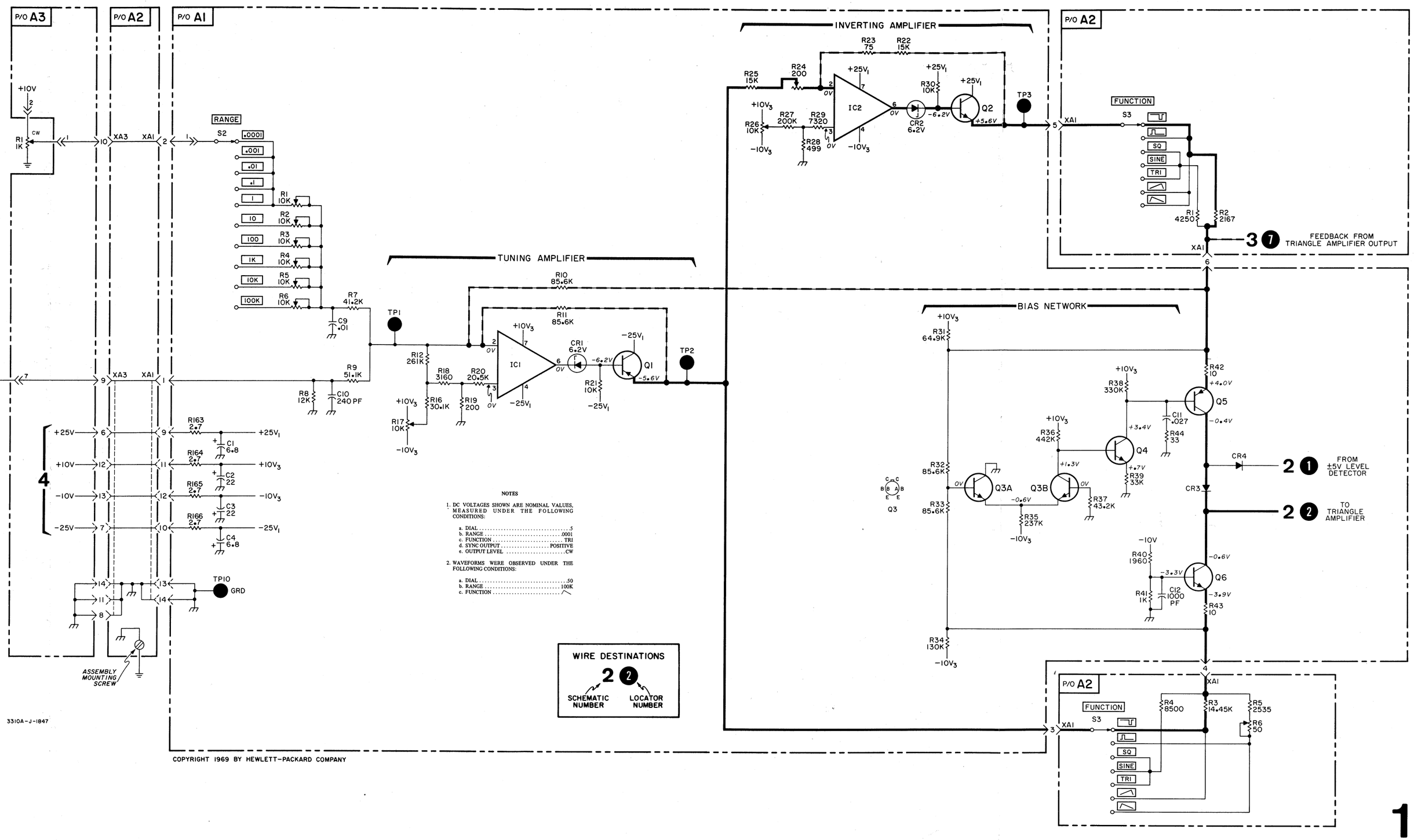
Figure 7-1. Functional Block Diagram



A1
hp Part No. 03310-66501
Rev B



COPYRIGHT 1969 BY HEWLETT-PACKARD C



NOTES

1. DC VOLTAGES SHOWN ARE NOMINAL VALUES, MEASURED UNDER THE FOLLOWING CONDITIONS:
   a. DIAL 5
   b. RANGE ..... .0001
   c. FUNCTION ..... TRI
   d. SYNC OUTPUT ..... POSITIVE
   e. OUTPUT LEVEL ..... CW
2. WAVEFORMS WERE OBSERVED UNDER THE FOLLOWING CONDITIONS:
   a. DIAL 50
   b. RANGE 100K
   c. FUNCTION ..... ⌒

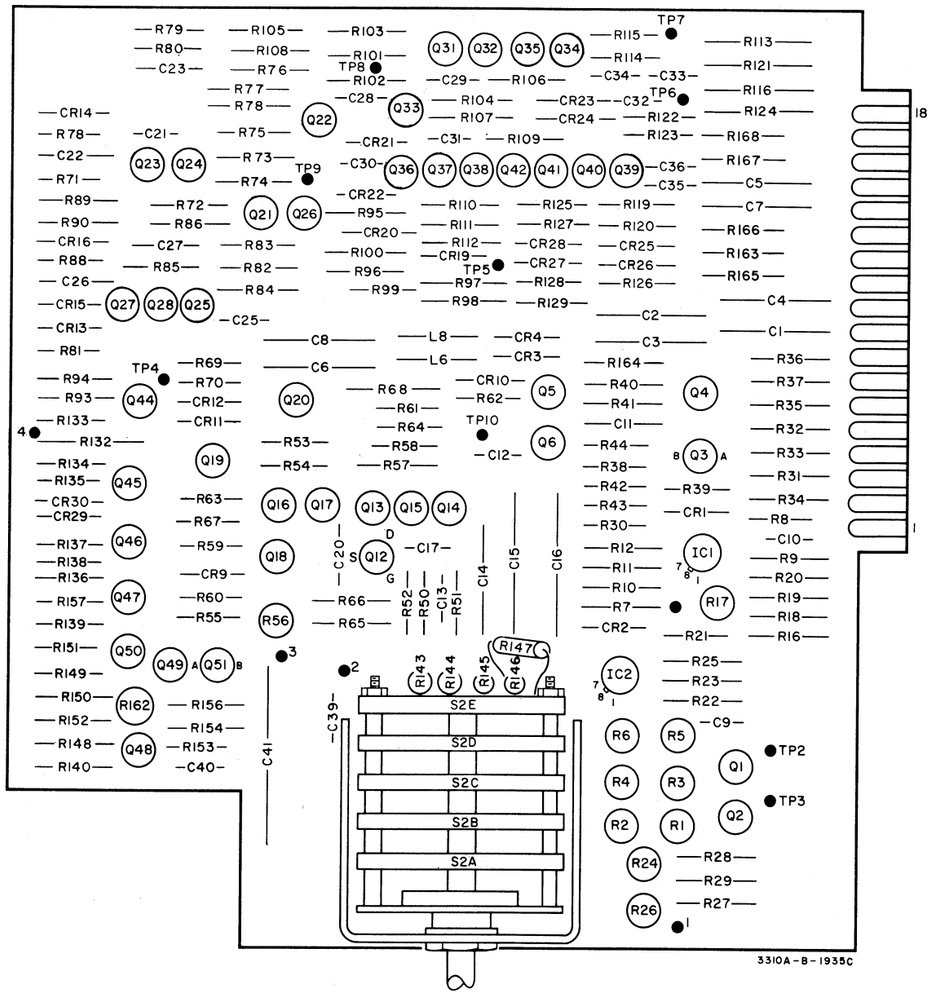
WIRE DESTINATIONS

2 (2)

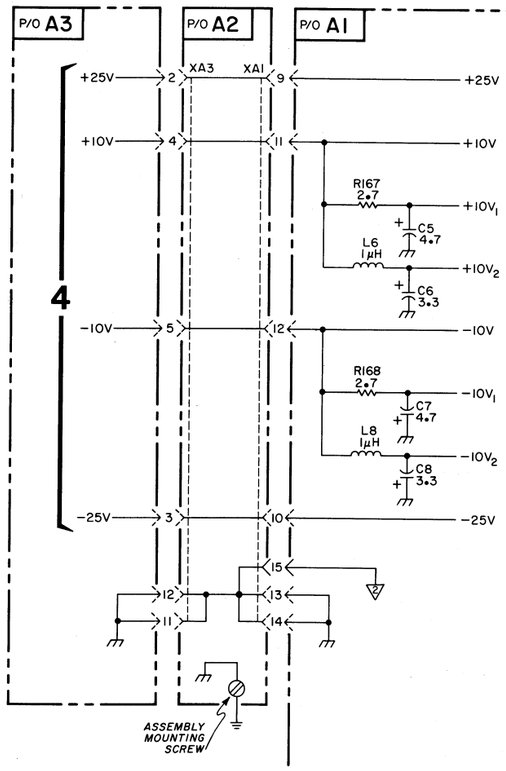
SCHEMATIC NUMBER — LOCATOR NUMBER

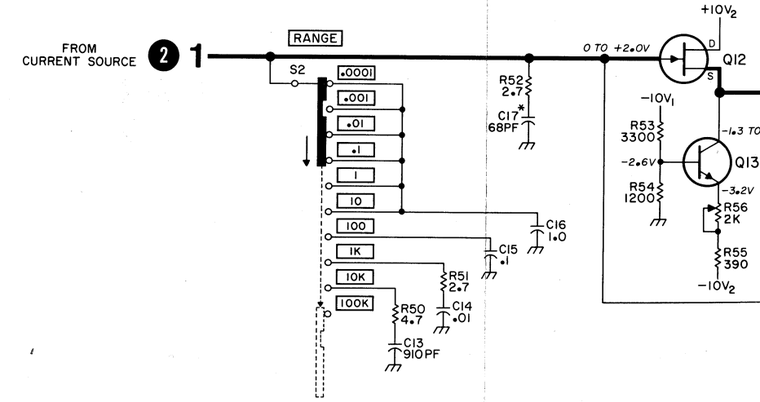
COPYRIGHT 1969 BY HEWLETT-PACKARD COMPANY

Figure 7-2. Tuning and Inverting Amplifiers, Current Sources



A1
hp Part No. 03310-66501
Rev B





3310A-J-1848

COPYRIGHT 1969 BY HEWLETT-PACKARD COMPANY

P/O A2 P/O A1

XA3 XA1

-25V 2 — 9 +25V

-10V 4 — 11 +10V

R167 2.7 — C5 4.7 — L6 1μH — C6 3.3 — +10V$_2$

-10V 5 — 12 -10V

R168 2.7 — C7 4.7 — L8 1μH — C8 3.3 — -10V$_2$

-25V 3 — 10 -25V

15 — 12 — 13 — 11 — 14

ASSEMBLY MOUNTING SCREW

FROM CURRENT SOURCE ❷ 1

RANGE S2: .0001 .001 .01 .1 1 10 100 1K 10K 100K

R52 2.7 — C17 68PF* — 0 TO +2.0V

C16 1.0 — C15 .1 — R51 2.7 — C14 .01 — R50 4.7 — C13 910PF

+10V$_2$ — Q12 (D, S) — +10V$_2$ — Q14 — Q15 — +8.1V — -0.9 TO +0.9V

-10V$_1$ — R53 3300 — -2.6V — Q13 — -3.2V — R56 2K — R55 390 — -10V$_2$

-1.3 TO +0.6V — 0 TO 2.0V — R57 909 — R58 82 — -10V$_2$ — -1.6 TO +0.2V

MUST BE MEASURED USING PROBE WITH <10pF CAPACITANCE

TRIANGLE AMPLIFIER

+10V$_2$ — R63 200

R59 200 — CR9 — +7.5V — Q16 — +8.1V — -3.8 TO +6.8V

R60 820 — R61 1600 — -8.0V — Q17 — -8.6V — R64 200 — CR10 — -10V$_2$

C20 3.3PF

+10V$_2$ — R67 100 — +9.4V — Q18 — -4.6 TO 6.2V — Q19 — -5.2 TO +5.6V

CR11 — R69 10 — CR12 — R70 10 — L9 — -5.3 TO 5.5V — -5.9 TO +4.9V — Q20 — R68 4020 — -25V — -10V$_2$

R65 98 — R66 402

TP4 -5.0 TO +5.0V

HIGH FREQUENCY LEVEL DETECTOR

+25V — R73 34K — -10V — Q22 — -10.4V — -9.8V

-25V — R72 140K — C21 1000 PF — Q21 — +0.6V — -10.0V — R74 2740 — R75 2870 — R77 2K — +10V — C23 .22

+0.3V TO +4.4V — CR13 — R71 100K — C22 1.0 — Q23 — +0.9V TO +5V — R76 100K — +25V — Q24 — +4.4V — CR14 — R78 100K — R79 4250 — R80 4080

RANGE S2: .0001 .001 .01 .1 1 10 100 1K 10K 100K — R93 500 — -10V

+25V — R83 34K — +10V — Q26 — +11V — +10.0V

+25V — R82 140K — C25 1000 PF — Q25 — +10.9V — +10.6V — R84 2740 — R85 2870 — R87 2K — -10V — C27 .22

-0.3 TO -4.4V — CR15 — R81 100K — C26 1.0 — Q27 — -0.9 TO +5.0V — R86 100K — -25V — Q28 — -4.4V — CR16 — R88 100K — R89 4250 — R90 4080

RANGE S2: .0001 .001 .01 .1 1 10 100 1K 10K 100K — R94 500 — +10V

CR19 — CR20

LOW FREQUENCY FEEDBACK AMPLIFIER

RANGE S2: .0001 .001 .01 .1 1 10 100 1K 10K 100K

R132 1640 — C39 1000 PF

+25V$_1$ — Q44 — -1.8V — -2.4V — R133 47 — R134 47 — Q45 — -3.0V — -25V$_1$

+25V$_1$ — R135 15K — CR29 — CR30

-25V$_1$ — Q46 — -20V — -20.6V — R137 5100 — R138 18K — -2.0V — R139 2K — Q47 — -23.5V — -24.1V — R136 330 — -25V$_1$

+0.2V — Q48 — -2.6V — R140 49.9K — -25V$_1$

RANGE S2: .0001 .001 .01 .1 1 10 100 1K 10K 100K — R143 20M — R144 2M — R145 199.8K — R146 19.8K — R147 1780

+25V$_1$ — R148 75K — +8.5V — R149 1K — +9.1V — Q49 — R150 34.8K — R151 1K — +9.1V — Q50 — R152 75K — +8.5V

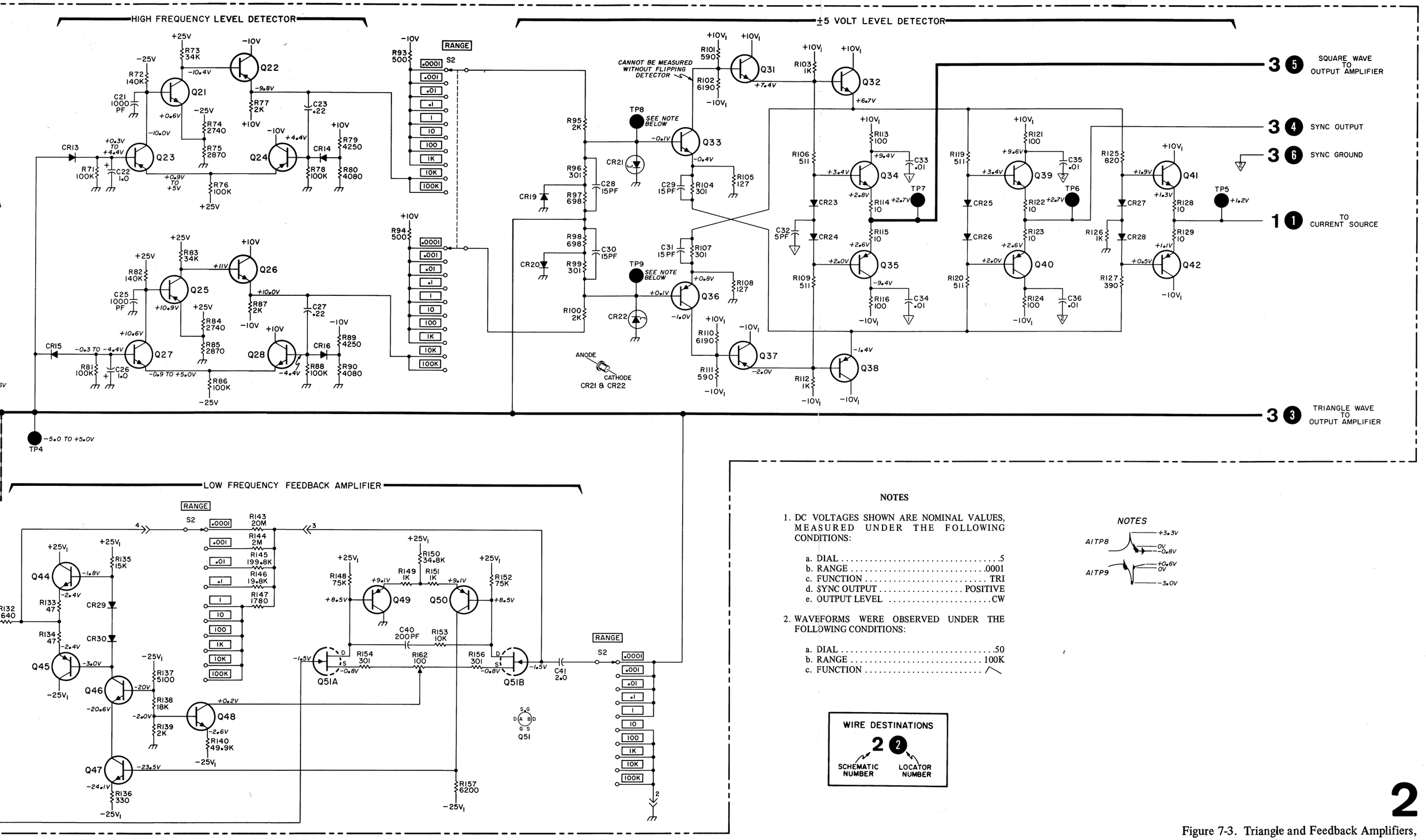
C40 200PF — R153 10K

-1.5V — Q51A (D, S) — R154 301 — -0.8V — R162 100 — R156 301 — -0.8V — Q51B (D, S) — -1.5V — C41 2.0

Q51 (S, G, D, A, B, D, G, S)

R157 6200 — -25V$_1$

COPYRIGHT 1969 BY HEWLETT-PACKARD COMPANY



NOTES

1. DC VOLTAGES SHOWN ARE NOMINAL VALUES, MEASURED UNDER THE FOLLOWING CONDITIONS:

   a. DIAL 5
   b. RANGE ..... .0001
   c. FUNCTION ..... TRI
   d. SYNC OUTPUT ..... POSITIVE
   e. OUTPUT LEVEL ..... CW

2. WAVEFORMS WERE OBSERVED UNDER THE FOLLOWING CONDITIONS:

   a. DIAL 50
   b. RANGE 100K
   c. FUNCTION ..... ∧

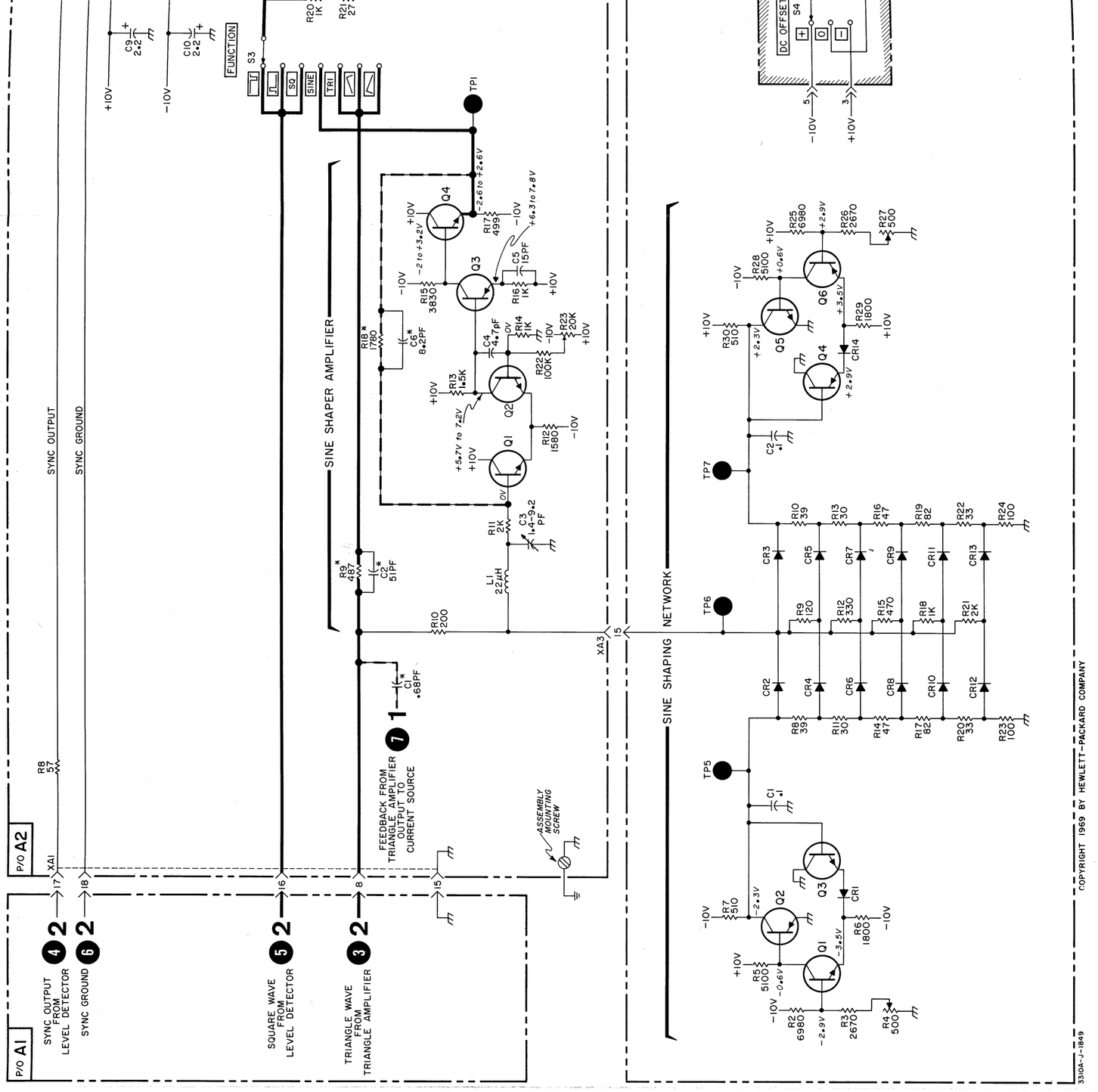
NOTES

WIRE DESTINATIONS

2 2

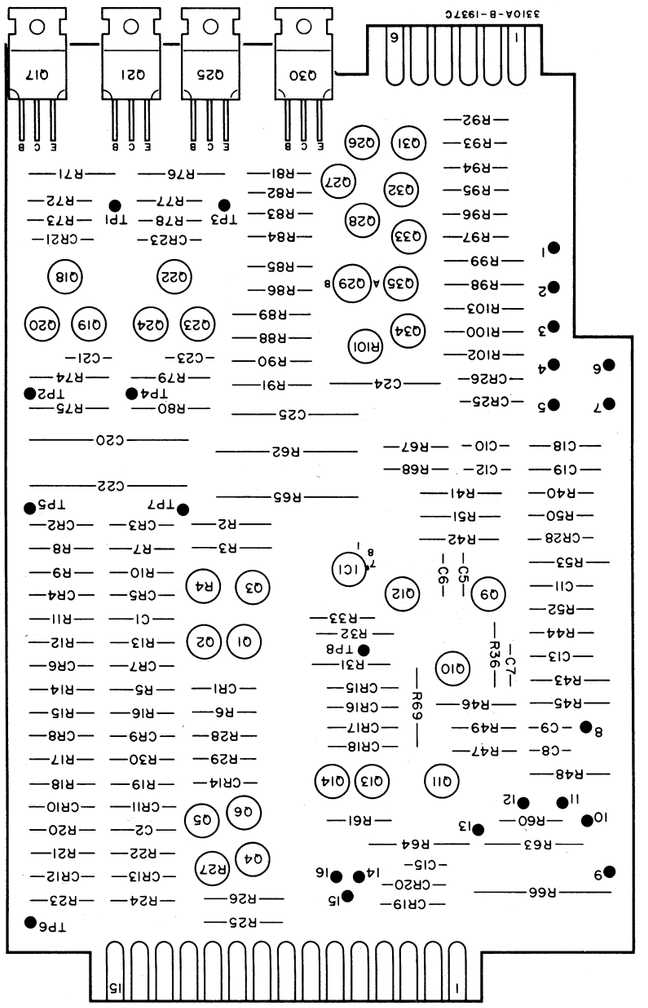
SCHEMATIC NUMBER — LOCATOR NUMBER

Figure 7-3. Triangle and Feedback Amplifiers, Level Detectors

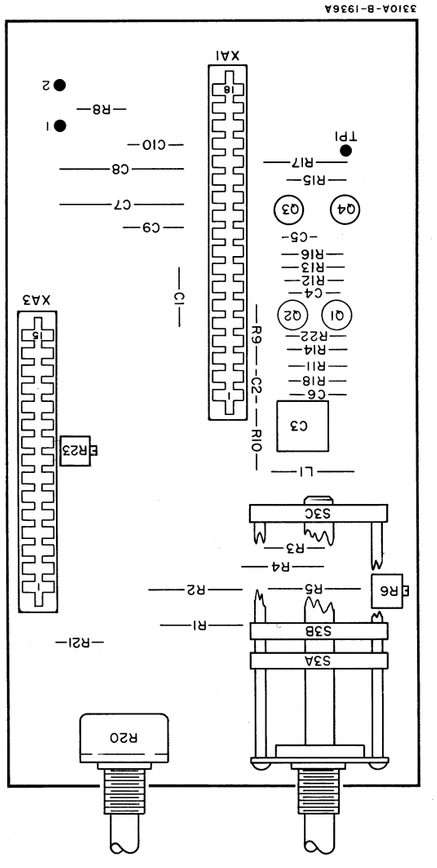


COPYRIGHT 1969 BY HEWLETT-PACKARD COMPANY

A3
hp Part No. 03310-66503
Rev C



A2
hp Part No. 03310-66502
Rev B



P/O A3

OUTPUT AMPLIFIER

SYNC OUTPUT 50Ω

FUNCTION

S3

SQ

SINE

TRI

DC OFFSET LEVEL

S4

TP1

TP8

XA3

J2

J3

J4

HIGH 50Ω

30 dB

LOW 50Ω

IC1

Q1 Q2 Q3 Q4 Q5 Q6 Q9 Q10 Q11 Q12 Q13 Q14

CR14 CR15 CR16 CR17 CR18 CR19 CR20 CR28 9.09V

R1 R2 R5 R6 R13 R14 R15 R16 R17 R18 R20 R21 R22 R23 R25 R26 R27 R28 R29 R30 R31 R32 R33 R36 R40 R41 R42 R43 R44 R45 R46 R47 R48 R49 R50 R51 R52 R53 R60 R61 R62 R63 R64 R65 R66 R67 R68 R69

C1 C2 C4 C5 C6 C7 C8 C9 C10 C11 C12 C13 C15 C18 C19

$C_{dist.}$

+10V −10V +25V +25V$_I$ −25V −25V$_I$

NOTES

1. DC VOLTAGES SHOWN ARE NOMINAL VALUES, MEASURED UNDER THE FOLLOWING CONDITIONS:
   a. DIAL 5
   b. RANGE 0001
   c. FUNCTION ..... TRI
   d. SYNC OUTPUT ..... POSITIVE
   e. OUTPUT LEVEL .....CW
2. WAVEFORMS WERE OBSERVED UNDER THE FOLLOWING CONDITIONS:
   a. DIAL 50
   b. RANGE 100K
   c. FUNCTION .....

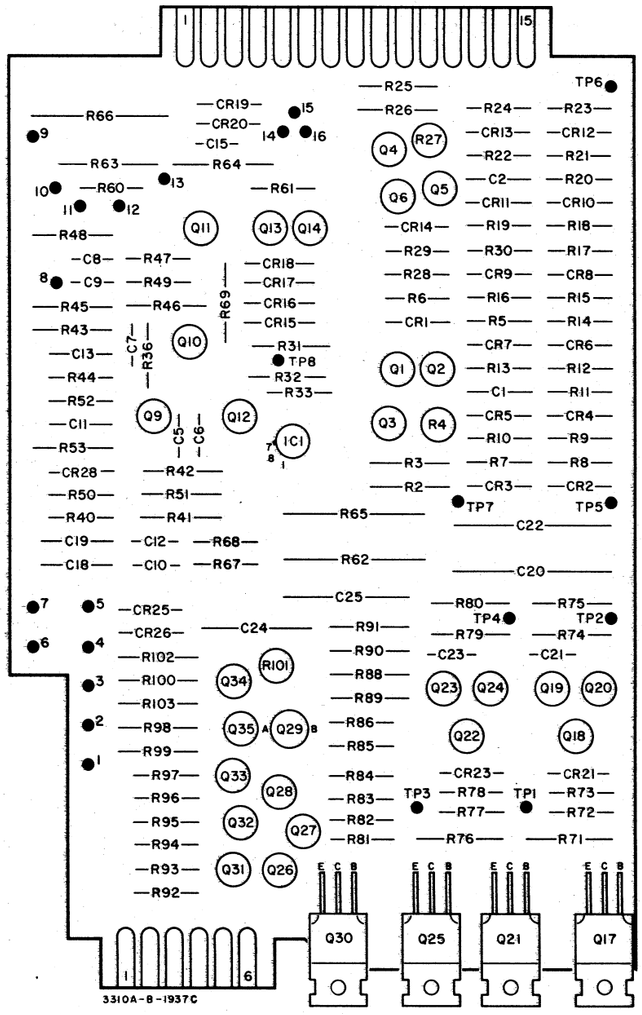
WIRE DESTINATIONS

2 (2)

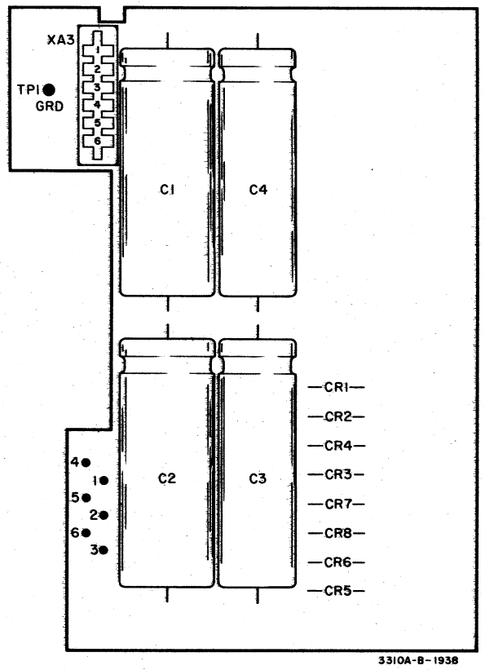
SCHEMATIC NUMBER — LOCATOR NUMBER

3

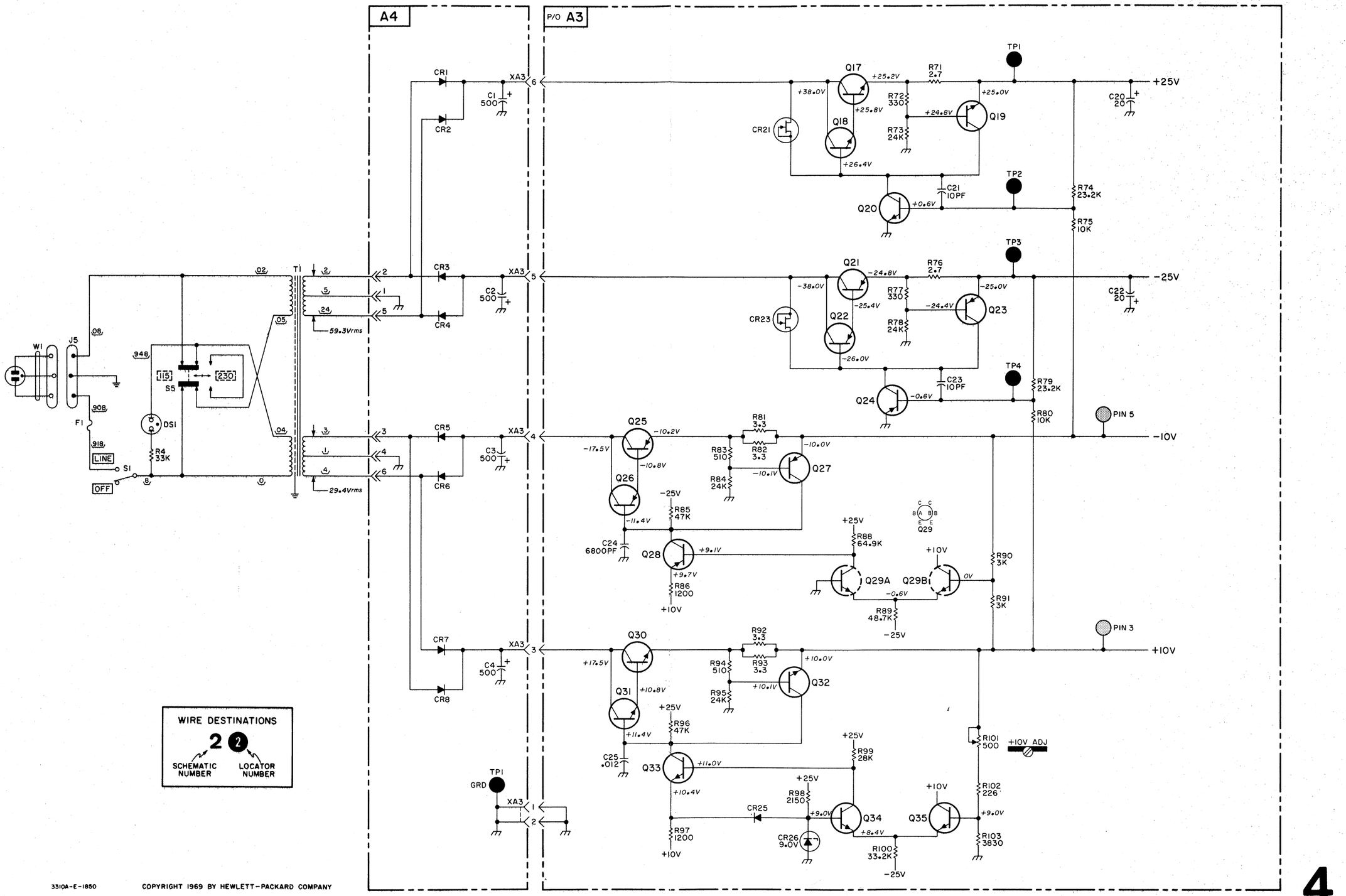
Figure 7-4. Sine Shaping and Output Circuits
7-9/7-10



A3
hp Part No. 03310-66503
Rev C



A4
hp Part No. 03310-66504



4

Figure 7-5. Power Supply

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven Ltd.	Whitby, Ontario Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Calif.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co.	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Calif.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08806	General Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15105	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Farmington, Mich.
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Ma.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17856	Siliconix Inc.	Sunnyvale, Calif.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
24796	Parelco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialities Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78424	Speciality Leather Prod. Co.	Newark, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N,J,
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96508	Xcelite Inc.	Orchard Park, N.Y.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

HEWLETT-PACKARD
SERVICE CENTERS AND FIELD OFFICES

UNITED STATES

ALABAMA
P.O. Box 4207
2003 Byrd Spring Road S.W.
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
3009 North Scottsdale Road
Scottsdale 85251
Tel: (602) 945-7601
TWX: 910-950-1282

5737 East Broadway
Tucson 85716
Tel: (602) 298-2313
TWX: 910-952-1162

CALIFORNIA
1430 East Orangethorpe Ave.
Fullerton 92631
Tel: (714) 870-1000

3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2591 Carlsbad Avenue
Sacramento 95821
Tel: (916) 482-1463
TWX: 910-367-2092

1055 Shafter Street
San Diego 92106
Tel: (714) 223-8103
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
508 Tolland Street
East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

111 East Avenue
Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

DELAWARE
3941 Kennett Pike
Wilmington 19807
Tel: (302) 655-6161
TWX: 510-666-2214

FLORIDA
P.O. Box 545
Suite 106
9999 N.E. 2nd Avenue
Miami Shores 33153
Tel: (305) 754-4565
TWX: 810-848-7262

P.O. Box 20007
Herndon Station 32814
621 Commonwealth Avenue
Orlando
Tel: (305) 841-3970
TWX: 810-850-0113

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
3839 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

LOUISIANA
P.O. Box 856
1942 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-0850

P.O. Box 1648
2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

MASSACHUSETTS
32 Hartwell Ave.
Lexington 02173
Tel: (617) 861-8960
TWX: 710-326-6904

MICHIGAN
24315 Northwestern Highway
Southfield 48075
Tel: (313) 353-9100
TWX: 810-232-1532

MINNESOTA
2459 University Avenue
St. Paul 55114
Tel: (612) 645-9461
TWX: 910-563-3734

MISSOURI
11131 Colorado Ave.
Kansas City 64137
Tel: (816) 763-8000
TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 962-5000
TWX: 910-760-1670

NEW JERSEY
W. 120 Century Road
Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1060 N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

NEW MEXICO
P.O. Box 8366
Station C
6501 Lomas Boulevard N.E.
Albuquerque 87108
Tel: (505) 255-5586
TWX: 910-989-1665

156 Wyatt Drive
Las Cruces 88001
Tel: (505) 526-2485
TWX: 910-983-0550

NEW YORK
1702 Central Avenue
Albany 12205
Tel: (518) 869-8462
TWX: 710-441-8270

1219 Campville Road
Endicott 13760
Tel: (607) 754-0050
TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

1025 Northern Boulevard
Roslyn, Long Island 11576
Tel: (516) 869-8400
TWX: 510-223-0811

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

NORTH CAROLINA
P.O. Box 5188
1923 North Main Street
High Point 27262
Tel: (919) 885-8101
TWX: 510-926-1516

OHIO
25575 Center Ridge Road
Cleveland 44145
Tel: (216) 835-0300
TWX: 810-427-9129

3460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

OKLAHOMA
2919 United Founders Boulevard
Oklahoma City 73112
Tel: (405) 848-2801
TWX: 910-830-6862

OREGON
Westhills Mall, Suite 158
4475 S.W. Scholls Ferry Road
Portland 97225
Tel: (503) 292-9171
TWX: 910-464-6103

PENNSYLVANIA
2500 Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

1021 8th Avenue
King of Prussia Industrial Park
King of Prussia 19406
Tel: (215) 265-7000
TWX: 510-660-2670

RHODE ISLAND
873 Waterman Ave.
East Providence 02914
Tel: (401) 434-5535
TWX: 710-381-7573

TEXAS
P.O. Box 1270
201 E. Arapaho Rd.
Richardson 75080
Tel: (214) 231-6101
TWX: 910-867-4723

6300 Westpark Drive
Houston 77027
Tel: (713) 781-6000
TWX: 910-881-2645

231 Billy Mitchell Road
San Antonio 78226
Tel: (512) 434-4171
TWX: 910-871-1170

UTAH
2890 South Main Street
Salt Lake City 84115
Tel: (801) 487-0715
TWX: 910-925-5681

VERMONT (Feb. 70)
P.O. Box 2287
Kennedy Drive
South Burlington 05401
Tel: (802) 658-4455
TWX: 710-658-4712

VIRGINIA
P.O. Box 6514
2111 Spencer Road
Richmond 23230
Tel: (703) 282-5451
TWX: 710-956-0157

WASHINGTON
433-108th N.E.
Bellevue 98004
Tel: (206) 454-3971
TWX: 910-443-2303

***WEST VIRGINIA**
Charleston
Tel: (304) 768-1232

FOR U.S. AREAS NOT LISTED:
Contact the regional office nearest you: Atlanta, Georgia . . . North Hollywood, California . . . Paramus, New Jersey . . . Skokie, Illinois. Their complete addresses are listed above.

*Service Only

CANADA

ALBERTA
Hewlett-Packard (Canada) Ltd.
11745 Jasper Ave.
Edmonton
Tel: (403) 482-5561
TWX: 610-831-2431

BRITISH COLUMBIA
Hewlett-Packard (Canada) Ltd.
1037 West Broadway
Vancouver 12
Tel: (604) 731-5301
TWX: 610-922-5059

MANITOBA
Hewlett-Packard (Canada) Ltd.
511 Bradford Ct.
St. James
Tel: (204) 786-7581
TWX: 610-671-3531

NOVA SCOTIA
Hewlett-Packard (Canada) Ltd.
2745 Dutch Village Rd.
Suite 203
Halifax
Tel: (902) 455-0511
TWX: 610-271-4482

ONTARIO
Hewlett-Packard (Canada) Ltd.
880 Lady Ellen Place
Ottawa 3
Tel: (613) 722-4223
TWX: 610-562-1952

Hewlett-Packard (Canada) Ltd.
50 Galaxy Blvd.
Rexdale
Tel: (416) 677-9611
TWX: 610-492-4246

QUEBEC
Hewlett-Packard (Canada) Ltd.
275 Hymus Boulevard
Pointe Claire
Tel: (514) 697-4232
TWX: 610-422-3022
Telex: 01-20607

FOR CANADIAN AREAS NOT LISTED:
Contact Hewlett-Packard (Canada) Ltd. in Pointe Claire, at the complete address listed above.

CENTRAL AND SOUTH AMERICA

ARGENTINA
Hewlett-Packard Argentina S.A.C.e.I
Lavalle 1171 - 3°
Buenos Aires
Tel: 35-0436, 35-0627, 35-0431
Telex: 012-1009
Cable: HEWPACKARG

BRAZIL
Hewlett-Packard Do Brasil I.e.C Ltda.
Rua Coronel: Oscar Porto, 691
Sao Paulo - 8, SP
Tel: 71-1503
Cable: HEWPACK Sao Paulo

Hewlett-Packard Do Brasil I.e.C. Ltda.
Avenida Franklin Roosevelt 84-grupo 203
Rio de Janeiro, ZC-39, GB
Tel: 232-9733
Cable: HEWPACK Rio de Janeiro

CHILE
Héctor Calcagni y Cia, Ltda.
Bustos, 1932-3er Piso
Casilla 13942
Santiago
Tel: 4-2396
Cable: Calcagni Santiago

COLOMBIA
Instrumentacion
Henrik A. Langebaek & Kier Ltda.
Carrera 7 No. 48-59
Apartado Aereo 6287
Bogota, 1 D.E.
Tel: 45-78-06, 45-55-46
Cable: AARIS Bogota
Telex: 044-400

COSTA RICA
Lic. Alfredo Gallegos Gurdián
Apartado 3243
San José
Tel: 21-86-13
Cable: GALGUR San José

ECUADOR
Laboratorios de Radio-Ingenieria
Calle Guayaquil 1246
Post Office Box 3199
Quito
Tel: 12496
Cable: HORVATH Quito

EL SALVADOR
Electrónica
Apartado Postal 1589
27 Avenida Norte 1133
San Salvador
Tel: 25-74-50
Cable: ELECTRONICA
San Salvador

GUATEMALA
Olander Associates Latin America
Apartado Postal 1226
Ruta 4, 6-53, Zona 4
Guatemala City
Tel: 63958
Cable: OLALA Guatemala City

JAMAICA
General Engineering Services, Ltd.
27 Dunrobin Ave.
Kingston
Tel: 42657
Cable: GENSERV

MEXICO
Hewlett-Packard Mexicana, S.A. de C.V.
Moras 439
Col. del Valle
Mexico 12, D.F.
Tel: 5-75-46-49

NICARAGUA
Roberto Terán G.
Apartado Postal 689
Edificio Terán
Managua
Tel: 3451, 3452
Cable: ROTERAN Managua

PANAMA
Electrónica Balboa, S.A.
P.O. Box 4929
Ave. Manuel Espinosa No. 13-50
Bldg. Alina
Panama City
Tel: 30833
Cable: ELECTRON Panama City

PERU
Fernando Ezeta B.
Avenida Petit Thouars 4719
Miraflores
Casilla 3061
Lima
Tel: 45-2335
Cable: FEPERU Lima

PUERTO RICO
San Juan Electronics, Inc.
P.O. Box 5167
Ponce de Leon 154
Pda. 3-Pta. de Tierra
San Juan 00906
Tel: (809) 725-3342
Cable: SATRONICS San Juan
Telex: SATRON 3450 332

URUGUAY
Pablo Ferrando S.A.
Comercial e Industrial
Avenida Italia 2877
Casilla de Correo 370
Montevideo
Tel: 40-3102
Cable: RADIUM Montevideo

VENEZUELA
Hewlett-Packard De Venezuela C.A.
Apartado 50933
Caracas
Tel: 71.88.05, 71.88.69, 71.99.30
Cable: HEWPACK Caracas

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard
INTERCONTINENTAL
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 326-7000
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8461

EUROPE

AUSTRIA
Unilabor GmbH
Wissenschaftliche Instrumente
Rummelhardtgasse 6/3
P.O. Box 33
Vienna A-1095
Tel: 42 61 81
Cable: LABORINSTRUMENT
Vienna
Telex: 75 762

BELGIUM
Hewlett-Packard Benelux S.A.
348 Boulevard du Souverain
Brussels 16
Tel: 72 22 40
Cable: PALOBEN Brussels
Telex: 23 494

DENMARK
Hewlett-Packard A/S
Langebjerg 6
2850 **Naerum**
Tel: (01) 80 40 40
Cable: HEWPACK AS
Telex: 66 40

FINLAND
Hewlett-Packard Oy
Gyldenintie 3
Helsinki 20
Tel: 67 35 38
Cable: HEWPACKOY-Helsinki
Telex: 12-1563

FRANCE
Hewlett-Packard France
Quartier de Courtaboeuf
Boite Postale No. 6
91 Orsay
Tel: 920 88 01
Cable: HEWPACK Orsay
Telex: 60048

Hewlett-Packard France
4 Quai des Etroits
69 **Lyon** 5ème
Tel: 42 63 45
Cable: HEWPACK Lyon
Telex: 31617

GERMANY
Hewlett-Packard Vertriebs-GmbH
Lietzenburgerstrasse 30
1 **Berlin W** 30
Tel: 24 60 65/66
Telex: 18 34 05

Hewlett-Packard Vertriebs-GmbH
Herrenbergerstrasse 110
703 Böblingen, Württemberg
Tel: 07031-6671
Cable: HEPAG Böblingen

Telex: 72 65 739
Hewlett-Packard Vertriebs-GmbH
Achenbachstrasse 15
4 **Düsseldorf** 1
Tel: 68 52 58/59
Telex: 85 86 533

Hewlett-Packard Vertriebs-GmbH
Berliner Strasse 117
6 **Nieder-Eschbach/Frankfurt 56**
Tel: (0611) 50 10 64
Cable: HEWPACKSA Frankfurt
Telex: 41 32 49

Hewlett-Packard Vertriebs-GmbH
Beim Strohhause 26
2 **Hamburg** 1
Tel: 24 05 51/52
Cable: HEWPACKSA Hamburg
Telex: 21 53 32

Hewlett-Packard Vertriebs-GmbH
Reginfriedstrasse 13
8 **München** 9
Tel: 0811 69 59 71/75
Cable: HEWPACKSA München
Telex: 52 49 85

GREECE
Kostas Karayannis
18, Ermou Street
Athens 126
Tel: 230303 232947
Cable: RAKAR Athens
Telex: 21 59 62 RKAR GR

IRELAND
Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks, England
Tel: Slough 753-33341
Cable: HEWPIE Slough
Telex: 84413

ITALY
Hewlett-Packard Italiana S.p.A.
Via Amerigo Vespucci 2
20124 **Milano**
Tel: 6251 (10 lines)
Cable: HEWPACKIT Milan
Telex: 32046

Hewlett-Packard Italiana S.p.A.
Palazzo Italia
Piazza Marconi 25
00144 **Rome - Eur**
Tel: 591 2544
Cable: HEWPACKIT Rome
Telex: 61514

NETHERLANDS
Hewlett-Packard Benelux, N.V.
Weerdestein 117
Amsterdam, Z 11
Tel: 42 77 77
Cable: PALOBEN Amsterdam
Telex: 13 216

NORWAY
Hewlett-Packard Norge A/S
Box 149
Nesveien 13
Haslum
Tel: 53 83 60
Cable: HEWPACK Oslo
Telex: 6621

PORTUGAL
Telectra
Rua Rodrigo da Fonseca 103
P.O. Box 2531
Lisbon 1
Tel: 68 60 72
Cable: TELECTRA Lisbon
Telex: 1598

SPAIN
Ataio Ingenieros
Ganduxer 76
Barcelona 6
Tel: 211-44-66

Ataio Ingenieros
Enrique Larreta 12
Madrid, 16
Tel: 235 43 44
Cable: TELEATAIO Madrid
Telex: 2 72 49

SWEDEN
Hewlett-Packard (Sverige) AB
Hagakersgatan 9C
S 431 04 **Mölndal** 4
Tel: 031 - 27 68 00

Hewlett-Packard (Sverige) AB
Svetsarvägen 7
S171 20 **Solna** 1
Tel: (08) 98 12 50
Cable: MEASUREMENTS
Stockholm
Telex: 10721

SWITZERLAND
Hewlett Packard (Schweiz) AG
Zurcherstrasse 20
8952 Schlieren
Zurich
Tel: (051) 98 18 21/24
Cable: HEWPACKAG Zurich
Telex: 53933

Hewlett Packard (Schweiz) A.G.
Rue du Bois-du-Lan 7
1217 Meyrin-**Geneva**
Tel: (022) 41 54 00
Cable: HEWPACKSA Geneva
Telex: 2 24 86

TURKEY
Telekom Engineering Bureau
P.O. Box 376 - Galata
Istanbul
Tel: 49 40 40
Cable: TELEMATION Istanbul

UNITED KINGDOM
Hewlett-Packard Ltd.
224 Bath Road
Slough, Bucks
Tel: Slough 33341
Cable: HEWPIE Slough
Telex: 84413

YUGOSLAVIA
Belram S.A.
83 avenue des Mimosas
Brussels 15, Belgium
Tel: 34 33 32, 34 26 19
Cable: BELRAMEL Brussels
Telex: 21790

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard S.A.
Rue du Bois-du-Lan 7
1217 Meyrin-**Geneva**
Tel: (022) 41 54 00
Cable: HEWPACKSA Geneva
Telex: 2.24.86

AFRICA, ASIA, AUSTRALIA

ANGOLA
Telectra Empresa Técnica
de Equipamentos Eléctricos
SAR
Rua de Barbosa Rodrigues
42-1°
Box 6487
Luanda
Cable: TELECTRA Luanda

AUSTRALIA
Hewlett-Packard Australia
Pty. Ltd.
22-26 Weir Street
Glen Iris, 3146
Victoria
Tel: 20.1371 (4 lines)
Cable: HEWPARD Melbourne
Telex: 31024

Hewlett-Packard Australia
Pty. Ltd.
61 Alexander Street
Crows Nest 2065
New South Wales
Tel: 43.7866
Cable: HEWPARD Sydney
Telex: 21561

Hewlett-Packard Australia
Pty. Ltd.
97 Churchill Road
Prospect 5082
South Australia
Tel: 65.2366
Cable: HEWPARD Adelaide

Hewlett Packard Australia
Pty. Ltd.
2nd Floor, Suite 13
Casablanca Buildings
196 Adelaide Terrace
Perth, W.A. 6000
Tel: 21-3330

CEYLON
United Electricals Ltd.
P.O. Box 681
Yahala Building
Staples Street
Colombo 2
Tel: 5496
Cable: HOTPOINT Colombo

CYPRUS
Kypronics
19-19D Hommer Avenue
P.O. Box 752
Nicosia
Tel: 6282-75628
Cable: HE-I-NAMI

ETHIOPIA
African Salespower & Agency
Private Ltd., Co.
P. O. Box 718
58/59 Cunningham St.
Addis Ababa
Tel: 12285
Cable: ASACO Addisababa

HONG KONG
Schmidt & Co. (Hong Kong) Ltd.
P.O. Box 297
1511, Prince's Building
10, Chater Road
Hong Kong
Tel: 240168, 232735
Cable: SCHMIDTCO Hong Kong

INDIA
The Scientific Instrument
Co., Ltd.
6, Tej Bahadur Sapru Road
Allahabad 1
Tel: 2451
Cable: SICO Allahbad

The Scientific Instrument
Co., Ltd.
12/5 Dickenson Road
Bangalore -1
Cable: SICO Bangalore

The Scientific Instrument
Co., Ltd.
240, Dr. Dadabhai Naoroji Road
Bombay 1
Tel: 26-2642
Cable: SICO Bombay

The Scientific Instrument
Co., Ltd.
11, Esplanade East
Calcutta 1
Tel: 23-4129
Cable: SICO Calcutta

The Scientific Instrument
Co., Ltd.
30, Mount Road
Madras 2
Tel: 86339
Cable: SICO Madras

The Scientific Instrument
Co., Ltd.
17, Kamalnayan Society
P.O. Navajiwan
Ahmedabad 14
Cable: SICO, Ahmedabad

The Scientific Instrument Co. Ltd.
5-8-525 Mahatma Gandhi Road
Hyderabad-1 (A-P) India
Cable: SICO Hyderabad

The Scientific Instrument Co., Ltd.
B-7, Ajmeri Gate Extn.
New Delhi 1
Tel: 27-1053
Cable: SICO New Delhi

INDONESIA
Bah Bolon Trading Coy. N.V.
Djalah Merdeka 29
Bandung
Tel: 4915 51560
Cable: ILMU
Telex: 809

IRAN
Telecom, Ltd.
P. O. Box 1812
240 Kh. Saba Shomali
Teheran
Tel: 43850, 48111
Cable: BASCOM Teheran

ISRAEL
Electronics & Engineering
Div. of Motorola Israel Ltd.
17 Aminadav Street
Tel-Aviv
Tel: 36941 (3 lines)
Cable: BASTEL Tel-Aviv
Telex: Bastel Tv 033-569

JAPAN
Yokogawa-Hewlett-Packard Ltd.
Nisei Ibaragi Bldg.
2-2-8 Kasuga
Ibaragi-Shi
Osaka
Tel: 23-1641

Yokogawa-Hewlett-Packard Ltd.
Ito Building
No. 59, Kotori-cho
Nakamura-ku, **Nagoya** City
Tel: 551-0215

Yokogawa-Hewlett-Packard Ltd.
Ohashi Building
59 Yoyogi 1-chrome
Shibuya-ku, **Tokyo**
Tel: 370-2281/7
Telex: 232-2024YHP
Cable: YHPMARKET TOK 23-724

KENYA
R. J. Tilbury Ltd.
P. O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 68206, 58196
Cable: ARJAYTEE Nairobi

KOREA
American Trading Co., Korea, Ltd.
P.O. Box 1103
Dae Kyung Bldg.
107 Sejong Ro
Chongro Ku
Seoul
Tel: 75-5841 (4 lines)
Cable: AMTRACO Seoul

LEBANON
Constantin E. Macridis
Clemenceau Street
P.O. Box 7213
Beirut
Tel: 220846
Cable: ELECTRONUCLEAR Beirut

MALAYSIA
MECOMB Malaysia Ltd.
2 Lorong 13/6A
Section 13
Petaling Jaya, **Selangor**
Cable: MECOMB Kuala Lumpur

MOZAMBIQUE
A. N. Goncalves, LDA.
4.1 Apt. 14 Av. D. Luis
P.O. Box 107
Lourenco Marques
Cable: NEGON

NEW ZEALAND
Hewlett-Packard (N.Z.) Ltd.
32-34 Kent Terrace
P.O. Box 9443
Wellington, N.Z.
Tel: 59-559
Cable: HEWPACK Wellington

PAKISTAN (EAST)
Mushko & Company, Ltd.
Zirat Chambers
31, Jinnah Avenue
Dacca
Tel: 280058
Cable: NEWDEAL Dacca

PAKISTAN (WEST)
Mushko & Company, Ltd.
Oosman Chambers
Victoria Road
Karachi 3
Tel: 511027, 512927
Cable: COOPERATOR Karachi

PHILIPPINES
Electromex Inc.
2129 Pasong Tamo
Makati, Rizal
P.O. Box 4326
Manila
Tel: 88-91-71 or 88-83-76
Cable: ELEMEX Manila

SINGAPORE
Mechanical and Combustion
Engineering Company Ltd.
9, Jalan Kilang
Singapore, 3
Tel: 642361-3
Cable: MECOMB Singapore

SOUTH AFRICA
Hewlett Packard South Africa
(Pty.), Ltd.
Hill House
43 Somerset Rd.
Cape Town
Tel: 3-6019
Cable: HEWPACK Cape Town
Telex: 7038CT

Hewlett Packard South Africa
(Pty.), Ltd.
P.O. Box 31716
30 De Beer Street
Braamfontein, Johannesburg
Tel: 724-4172 724-4195
Telex: 0226 JH
Cable: HEWPACK Johannesburg

TAIWAN REP. OF CHINA
Hwa Sheng Electronic Co., Ltd.
P. O. Box 1558
Room 404
Chia Hsin Building
No. 96 Chung Shan
North Road, Sec. 2
Taipei
Tel: 555211 Ext. 532-539
545936, 546076, 548661
Cable: VICTRONIX Taipei

TANZANIA
R. J. Tilbury Ltd.
P.O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 26803, 68206, 58196
Cable: ARJAYTEE Nairobi

THAILAND
The International
Engineering Co., Ltd.
P. O. Box 39
614 Sukhumvit Road
Bangkok
Tel: 910722 (7 lines)
Telex: INTENCO BK 226
Cable: GYSOM BANGKOK

UGANDA
R. J. Tilbury Ltd.
P.O. Box 2754
Suite 517/518
Hotel Ambassadeur
Nairobi
Tel: 25670, 26803, 68206, 58196
Cable: ARJAYTEE Nairobi

VIETNAM
Peninsular Trading Inc.
P.O. Box H-3
216 Hien-Vuong
Saigon
Tel: 20.805
Cable: PENINSULA Saigon

ZAMBIA
R. J. Tilbury (Zambia) Ltd.
P.O. Box 2792
Lusaka
Zambia, Central Africa

FOR AREAS NOT LISTED, CONTACT:
Hewlett-Packard
INTERCONTINENTAL
3200 Hillview Ave.
Palo Alto, California 94304
Tel: (415) 326-7000
TWX: 910-373-1267
Cable: HEWPACK Palo Alto
Telex: 034-8461

MANUAL BACKDATING CHANGES

Model 3310A

FUNCTION GENERATOR

Manual Serials Prefixed: 947-

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
920-00111 and below	1		
920-0450 and below	1, 2		
947-01200 and below	1 thru 3		
947-01450 and below	1 thru 4		
947-01700 and below	1 thru 5		
947-01950 and below	ALL		

CHANGE NO.1

Page 7-7/7-8, Figure 7-3

Delete Ferrite bead (L9) on the base of A1Q20.

Page 6-2, Table 6-1

Delete L9, Ferrite bead, Part No. 9170-0016.

CHANGE NO. 2

Page 6-4

Change A1R54 to R: fxd comp 1200 ohms 5% 1/4 W (0683-1225).

Change A1R55 to R: fxd comp 390 ohms 5% 1/4 W (0683-3915).

Page 6-10

Delete vernier drive plate assembly (03310-60605) and add spring: vernier (03310-09191).

Delete Assembly: heat sink spacer (03310-24701).

Page 7-7/7-8

Change A1R54 and A1R55 to 1200 ohms and 390 ohms, respectively.

CHANGE NO. 3

Table 6-1

Delete Panel: Rear (03310-00203). (Miscellaneous).

Add Panel: Rear (03310-00202). (Miscellaneous).

Delete J5, Connector: Power (1251-2357).

Add J5, Connector: Power (1251-0148).

Delete W1, Cord: Power (8120-1348).

Add W1, Cord: Power (8120-0078).

CHANGE NO. 4

Table 6-1

Delete A1R163 thru A1R168 and add A1L1 thru A1L5 and A1L7, Inductor: fxd 20uH 10% (9140-0047).

NOTE

It is recommended that inductors L1 thru L5 and L7 be replaced by the resistors R163 and R168 as indicated in the manual if replacement becomes necessary.

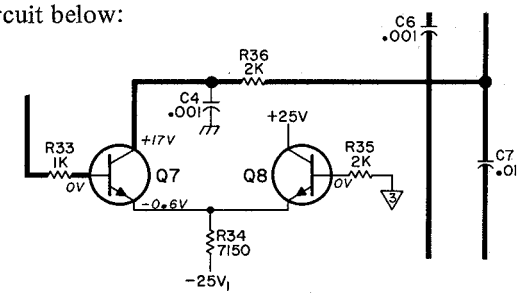
CHANGE NO. 5

Table 6-1

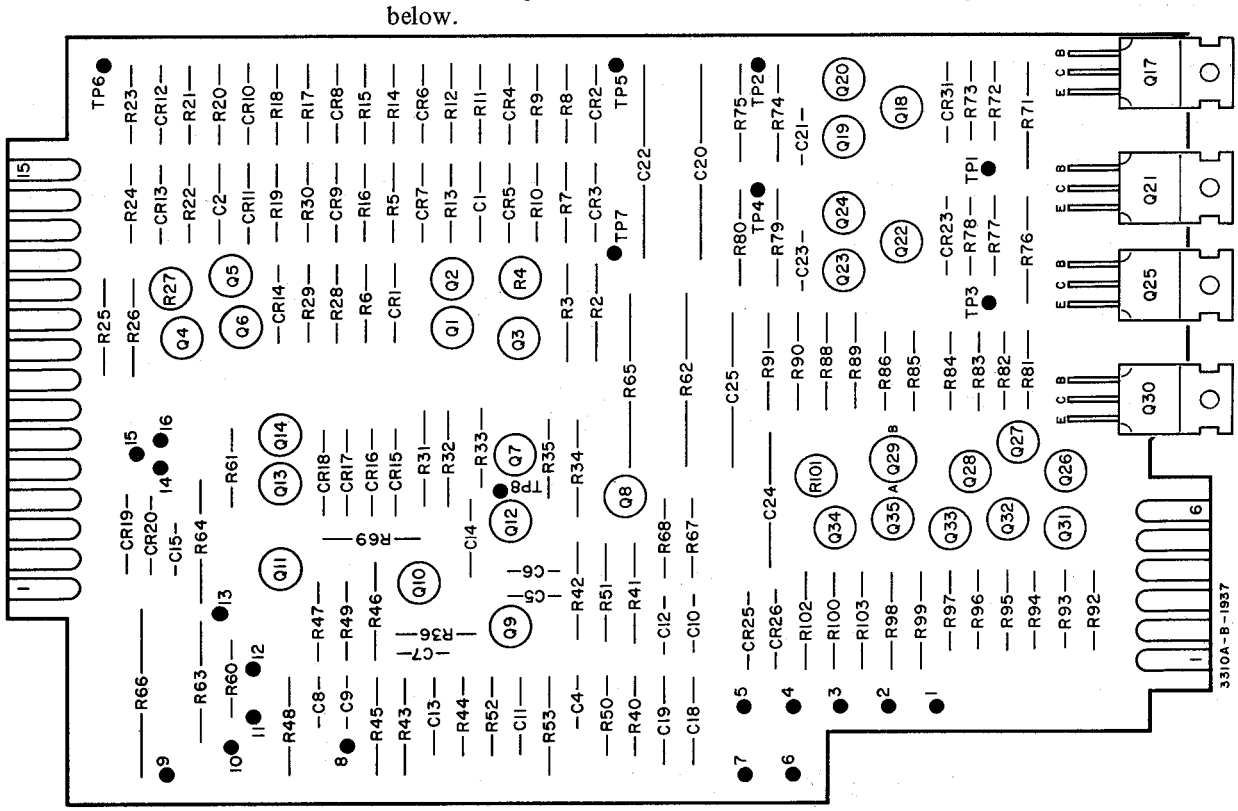
Delete A3IC1 (1820-0203) and A3CR28 (1902-0681).
Add A3Q7 and A3Q8 (1854-0215).
Add A3R34, 7150 ohms fxd flm 1% 1/8 W (0698-4471).
Delete A3R36, A3C5, and A3C6 and add A3R35 and A3R36, 2000 ohms fxd comp 5% 1/4 W (0683-2025).
Add A3C4, A3C5, and A3C6, 0.001uF fxd cer 500 vdcw (0150-0069).

Figure 7-4

Delete A3R33, A3R36, A3IC1, A3CR28, A3C5 and A3C6. Replace with circuit below:



Change A3C13 and A3R43 near Q9 to .1uF and 357 ohms respectively.
Change C11 near Q12 to .1uF.
Delete the component location diagram for the A3 board as shown in Figures 7-4 and 7-5 and substitute the diagram shown below.



CHANGE NO. 6

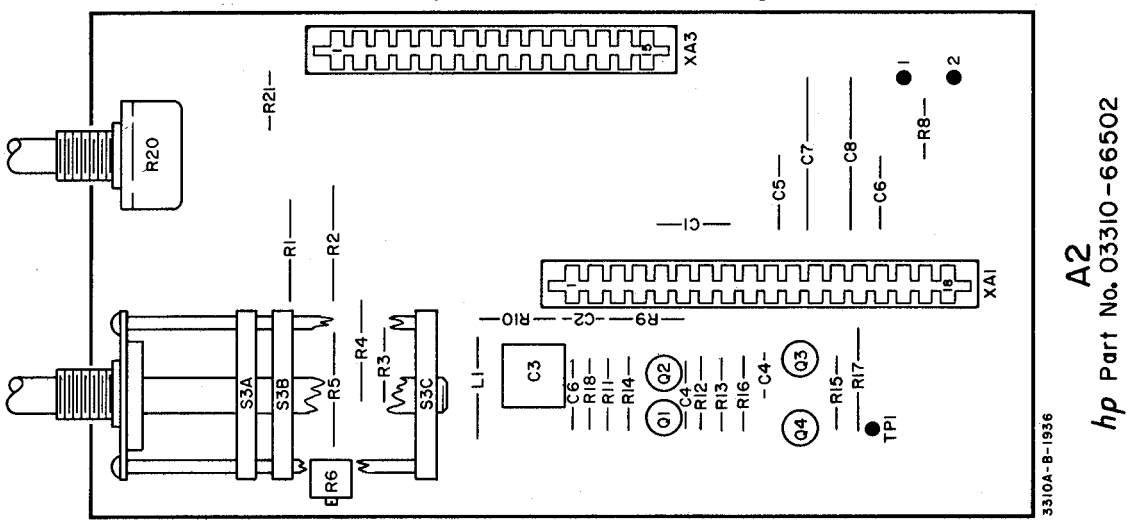
Table 6-1

Delete A2R22 (0757-0465) and A2R23 (2100-2514).

Figure 7-4

Delete resistors A2R22 and A2R23 near A2Q2. Connect A2C4 from collector of A2Q2 to circuit ground.

Delete the component location diagram for the A2 board as shown in Figure 7-4 and substitute the diagram shown below.



HEWLETT hp PACKARD
GmbH

MANUAL CHANGES

MODEL 3310 A

FUNCTION GENERATOR

Manual Serial Prefixed: 947-
-hp- Part No. 03310-90001

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

Instrument Serial Prefixes		Make Manual Changes
G-959-00221	and above	

ERRATA: Paragraph 5-47:
Change the reference to 10 µs in the last sentence to 1 µs.
Paragraph 5-48:
Change the reference to 100 µs to 10 us.
Paragraph 5-49:
Change reference to 200 ms in the third sentence to 20 ms.

Table 5-1:
Change the Thermal Converter Voltage Input to 3 Vrms.
Table 6-1:

			-hp- Stock No.
Delete:	Bracket - terminal Part No. 03310-00606	(miscellaneous)	
Add:	Stock No. to A1R157		0683-6225
Change:	Stock No. of A1R156 to		0757-0410

Page 6-2, Table 6-1

Add:	A1L9	Ferrite bead	9170-0016

Page 7-7 / 7-8 Figure 7-3
Change value of A1R54 to 4.7 K and A1R55 to 270 Ohm

Table 6-1 and schematic diagrams:

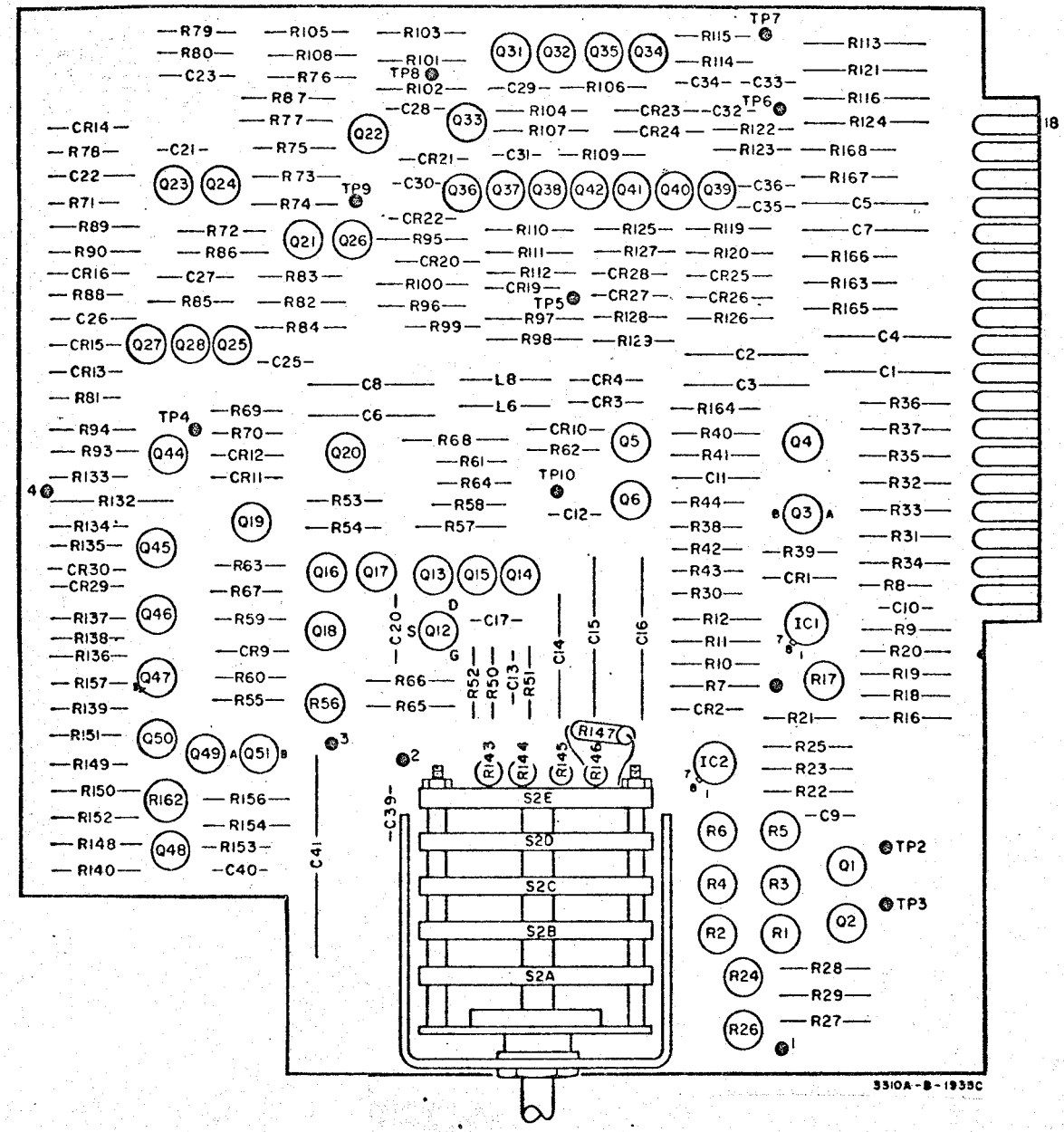
Change:	A1R163 thru 168	R:fxd., 2.7 Ohm, ± 10%, 1/4W to	0684-0271
	A1Q36,37	to TSTR:Si PNP 2N3640	1853-0015
	03310-00202	Panel - rear to	03310-00203
	W1	Cord - power (Schuko) to	8120-1349

MODEL 3310A

ERRATA: (Cont.)

			-hp- Stock No.
Change:	A2R21	to R:fxd., comp 27 Ohm, ± 5%, 1/4W	0683-2705
	A3CR28	to Diode - Zener 15V	1902-3205
	A3R72,77	to R:fxd., comp. 510 Ohm, ±5%, 1/4W	0683-5115
	Q1	TSTR:Si NPN to	1854-0013

Delete: A3R35



A1

hp Part No. 03310-66501

Rev C